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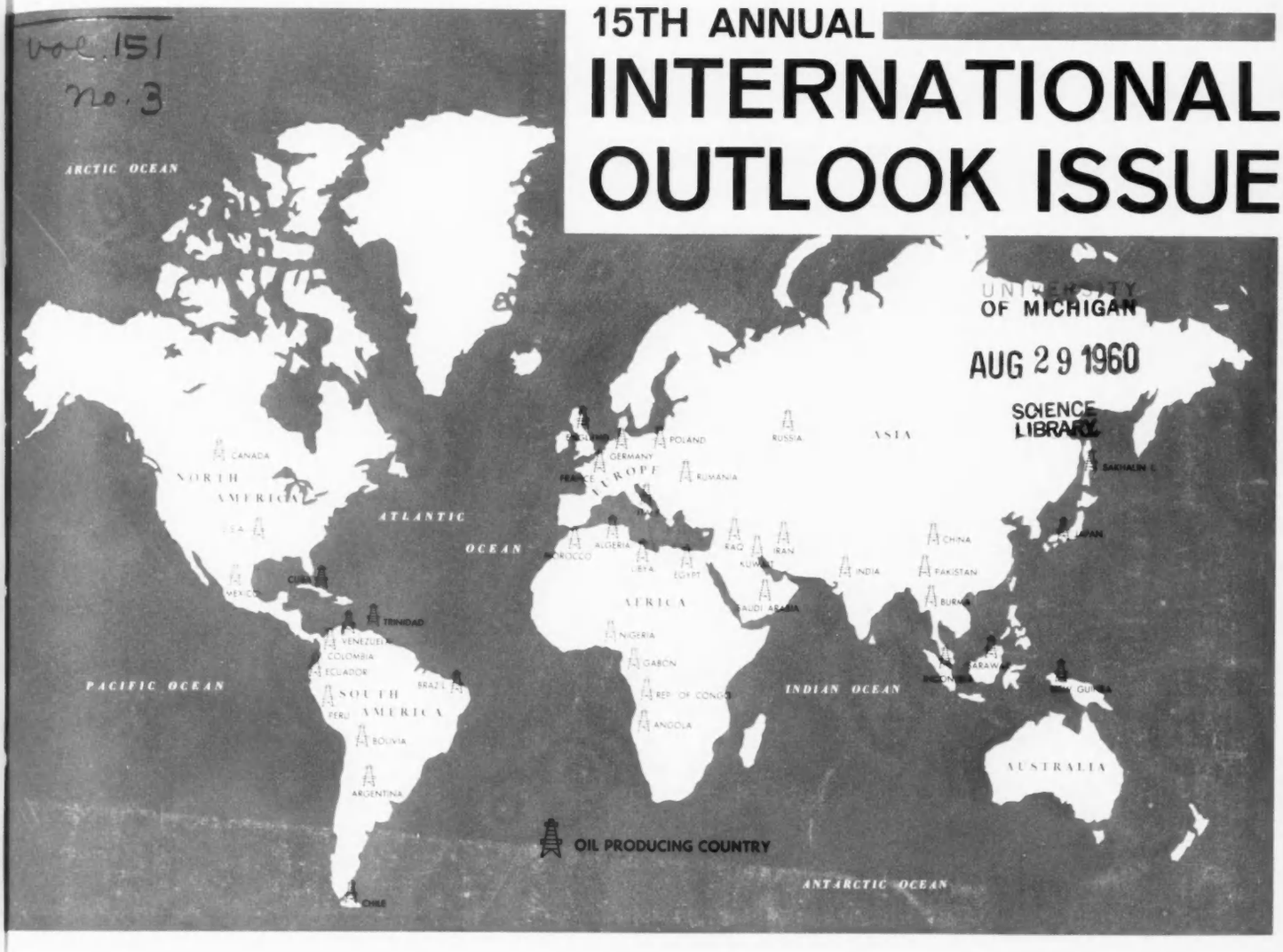

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WORLD OIL

SPECIALIZED FOR EXPLORATION, DRILLING AND PRODUCING OPERATIONS AND MANAGEMENT

World industry continues vigorous 91
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Asia: Middle East output still rises 180

AUGUST 15, 1960

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WORLD OIL'S 1960 INTERNATIONAL OUTLOOK ISSUE

ESTABLISHED 1916 AS THE OIL WEEKLY

AUGUST 15, 1960 VOL. 151, NO. 3

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a QUICK LOOK at this issue

(WORLD OIL's 15th annual International Outlook issue)

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

☐ **World trends continue upward . . .** Petroleum industry operations remain vigorous throughout the world. To meet demand, daily crude oil production must go up about 1 million barrels each year. Record crude reserves provide huge producing ability. But exploration and drilling hold up well. . . . . **Page 91**

☐ **World drilling . . .** WORLD OIL forecasts 5,403 well completions outside the U.S. and Canada this year, up 360 wells or 7% over 1959. But U.S. and Canada decreases will hold the Free World total to 54,347 completions, down 2,883 wells or 5% from 1959. . **Page 92**

☐ **World demand and supply . . .** Oil consumption is rising about one million barrels daily each year. World demand rose 6.5% to 20,473,000 bpd in 1959. Similar gains are forecast several years ahead. Even so, world supply exceeded demand by 117,500 bpd in 1959. Saudi Arabia and Venezuela propose international prorationing to cut surpluses. . . . . **Page 94**

☐ **World crude oil reserves . . .** Total increased 11 billion barrels or 4.5% in 1959 to new high of 256 billion. Kuwait continues to lead the world, with 60 billion barrels. Saudi Arabia has 48 billion. Middle East reserves now total 158 billion barrels, 61.7% of the world total. That compares with 31.7 billion in the U.S. and 23 billion in the Soviet Union. . . . . **Page 95**

☐ **World crude oil production . . .** Output is forecast at 20,458,000 barrels daily in 1960. That would be 978,000 bpd or 5% above 1959 and above 20 million for the first time. The 19,480,215 bpd produced in 1959 was an increase of 1,389,268 barrels or 7.7% over the 18,090,947 of 1958 . . . . . **Page 96**

☐ **World geophysical activity . . .** Exploration continues to decline. The Free World recorded 11,481 party-months last year, down 8.8% from 1958. But significant increases in seismograph activity were reported in the U.S., Argentina and Africa. A small increase in activity also was reported in the Far East. . . . . **Page 98**

☐ **North America: Mexico expands . . .** Sharp increases in oil and gas use in Mexico require expansion of operations. Canada set records in oil and gas production in 1959 and will further expand this year. The United States now is achieving better balance between supply and demand, and is hoping for stronger markets and better prices henceforth. . . . . **Page 100**

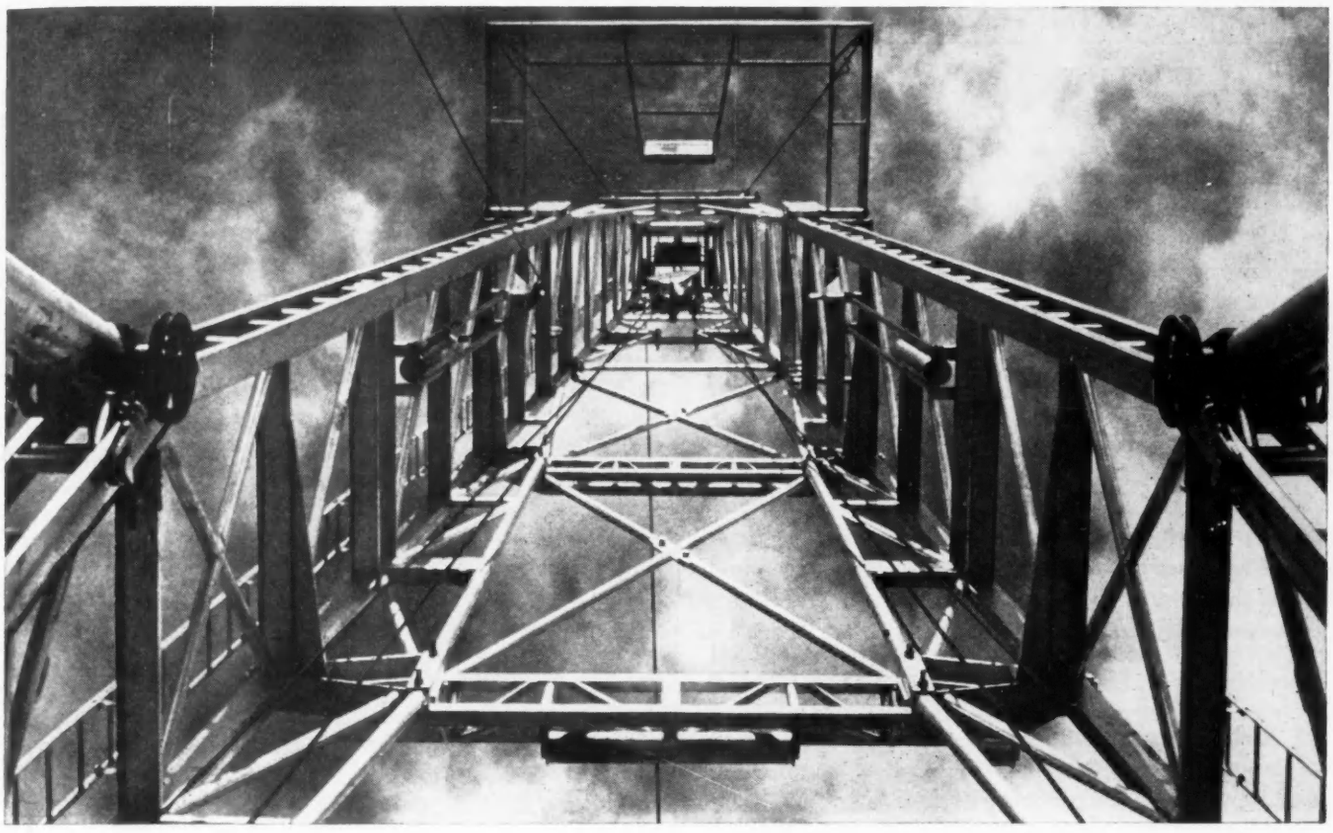
☐ **U.S. demand and supply . . .** More crude oil is needed to meet a 3.5% increase in oil demand in 1960. Total demand for all oils will average 9,998,000 barrels per day, up 3.5% from 1959. New supply needs should average 9,858,000 bpd, up 145,000 barrels or 1.5%. Total imports will remain about the same as in 1959. Crude oil production should average 7,158,000 bpd, up 1.5% . . . . . **Page 100**

☐ **U.S. drilling forecast.** U.S. operators are expected to drill 23,721 wells in latter half of 1960, up 1,118 wells or 4.9% over the first half. WORLD OIL forecasts that 46,324 wells will be drilled this whole year, about 3,000 less than in 1959. Footage will total 194 million feet in 1960, down 11.7 million. . . . . **Page 102**

☐ **Canada emphasizes natural gas . . .** With its crude oil production held to only 50% of potential, Canada is stepping up efforts to find new natural gas reserves. While liquid hydrocarbon production was up 3% last year, lower prices dropped revenue to $450 million or 1% under the record $454 million in 1957 . . . . . **Page 104**

☐ **Central America and West Indies . . .** Oil and gas activity lag. Central America has no established fields, and the search for petroleum has been discouraged by the surpluses in other countries. The West Indies islands have had similar experience, and development had been limited largely to drilling in the proved fields of Trinidad . . . . . **Page 111**

☐ **South America: Upward trends continue . . .** Venezuela produced over one billion barrels of oil last year, almost equalling the 1957 record. Discoveries were reported in Argentina's Comodoro Rivadavia area and on both the Chilean and Argentine sides of Tierra del Fuego. Field development increased Brazil's production to 75,000 bpd. . . . . **Page 116**



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a Quick Look at this issue . . .

☐ **West Europe pushes development . . .** Exploration, drilling, and production continue to expand. Increased drilling boosted France's Paris Basin oil production to 8,700 barrels daily last year. Production increases also were reported in Sicily, West Germany, and Yugoslavia. New natural gas reserves were found in Italy, and a new drilling depth record was set in Spain. . . **Page 135**

☐ **East Europe: Satellite production declines . . .** Soviet oil production increased 25% last year, but still is only about one-third the U.S. 1959 rate of 7 million barrels per day. Seven satellite countries averaged 273,357 bpd last year, continuing a downward trend. New oil finds were reported in the Patos and Mariz areas of Albania . . . . . **Page 146**

☐ **Africa: Exploration at all-time high . . .** Africa is experiencing the most extensive oil search in its history. In Libya, major oil reserves continue to be found. Several oil companies have started exploration programs in the Spanish Sahara. Nigeria and Gabon are becoming important oil-producing countries. Recent discoveries indicate possible oil production in Senegal and Cameroon . . . . . **Page 150**

☐ **Middle East: Activity still increasing . . .** A major oil field was discovered at Sarajeh, establishing commercial production in central Iran. Large oil fields also were proven offshore in the Persian Gulf in the Neutral Zone and Abu Dhabi, and offshore wildcats in search of similar fields are underway in Iran and Bahrain . . . . . **Page 180**

☐ **Far East: Oil and gas are actively sought . . .** Oriental nations are pulling all stops to develop domestic oil and gas sources to fuel stronger economies. Development of a new oil province at Cambay in western India was of signal importance. Assam discoveries are expected to boost oil production six-fold by 1962. Exploration for onshore gas and offshore oil in Japan is booming . . . . . **Page 236**

☐ **Oceania: Philippines gain first oil field . . .** A discovery well on Cebu Island yielded the Philippines' first commercial crude production. Thus a missing link in the producing chain between Java, Sumatra and Borneo to the south and Taiwan, Japan, and Sakhalin to the north was filled. Renewed efforts to find domestic sources in oil-hungry Australia continue. . . . . **Page 272**

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WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry.
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PETROLEUM REFINER and The REFINERY CATALOG for the oil, gas and petrochemical processing industry.

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Offshore oil search is a worldwide endeavor

OIL EXPLORATION beneath the seas is gathering momentum outside the United States and will become commonplace in many areas in the future. As in the case of other technological advances initiated in the U.S. and Venezuela, operators abroad will benefit by the operating experience gained in America.

Offshore drilling is proceeding in South America not only in Lake Maracaibo but also near the Venezuela-Trinidad border in the Gulf of Paria; and in Brazil and Peru. Empresa Nacional del Petroleo has completed a number of oil wells under the Strait of Magellan by directional drilling, and contemplates offshore drilling in the Strait to develop anticipated oil reserves there.

In Europe, BP Exploration Company, Ltd. appears to have completed a commercial discovery in Dorset in south England, and has conducted seismograph work in the English Channel, presaging future offshore drilling aimed at developing a possible trend continuous with the Paris Basin. The French are investigating offshore drilling techniques. Seismic work has been done in the North Sea off Holland and West Germany.

Important sources of offshore oil have been proven in the Persian Gulf at Safaniya and Manifa in Saudi Arabia, in the Neutral Zone, and at Umm Shaif in Abu Dhabi.

Thanks to long-established traditions of freedom of the seas which have been codified into international law, the oil industry may look forward to relatively clear sailing in the search for offshore oil. Of course, problems will be encountered. Many islands in the Persian Gulf, some of them uninhabited, may become sources of contention between nearby nations as oil makes them worth claiming. Disputes there are not restricted to small islands. Iran continues to press its ancient claim to Bahrain. Disputes over islands automatically complicate offshore rights matters. Offshore oil discovery and production will produce new problems. Other nations will study the experience of the U.S.

Two United Nations conferences on the Law of the Sea have taken place, in the spring of 1958 and 1960. Much has been made of the fact that neither meeting achieved agreement on the breadth of exclusive territorial rights offshore. Several clear principles, however, have emerged from these meetings.

First, all nations agree that each country has the sovereign right to develop mineral resources on the continental shelf continuous with its borders and land mass. However, such right does preclude the innocent passage of other nations' ships, whether they be tankers or fishing vessels. Last spring's conference was deadlocked mainly because some nations favored the three-mile limit in order to be allowed to fish almost everywhere. Others wanted a 12-mile limit to exclude others from coastal fishing grounds.

Otherwise, the tone of debate gives rise to optimism. Attempts are being made to define the edge of the continental shelf as being at 200 meters (656 feet) of water depth. Actually, it may average 435 feet. Concern has been expressed whether mariners' charts can be kept up to date with respect to construction of new offshore installations. Consideration has been given to safety zones bordering offshore installations; to shipping channels with appropriate signals through offshore fields; and to the danger of fire in such fields from possible accidental ignition of hydrocarbon vapors by crewmen of passing ships.

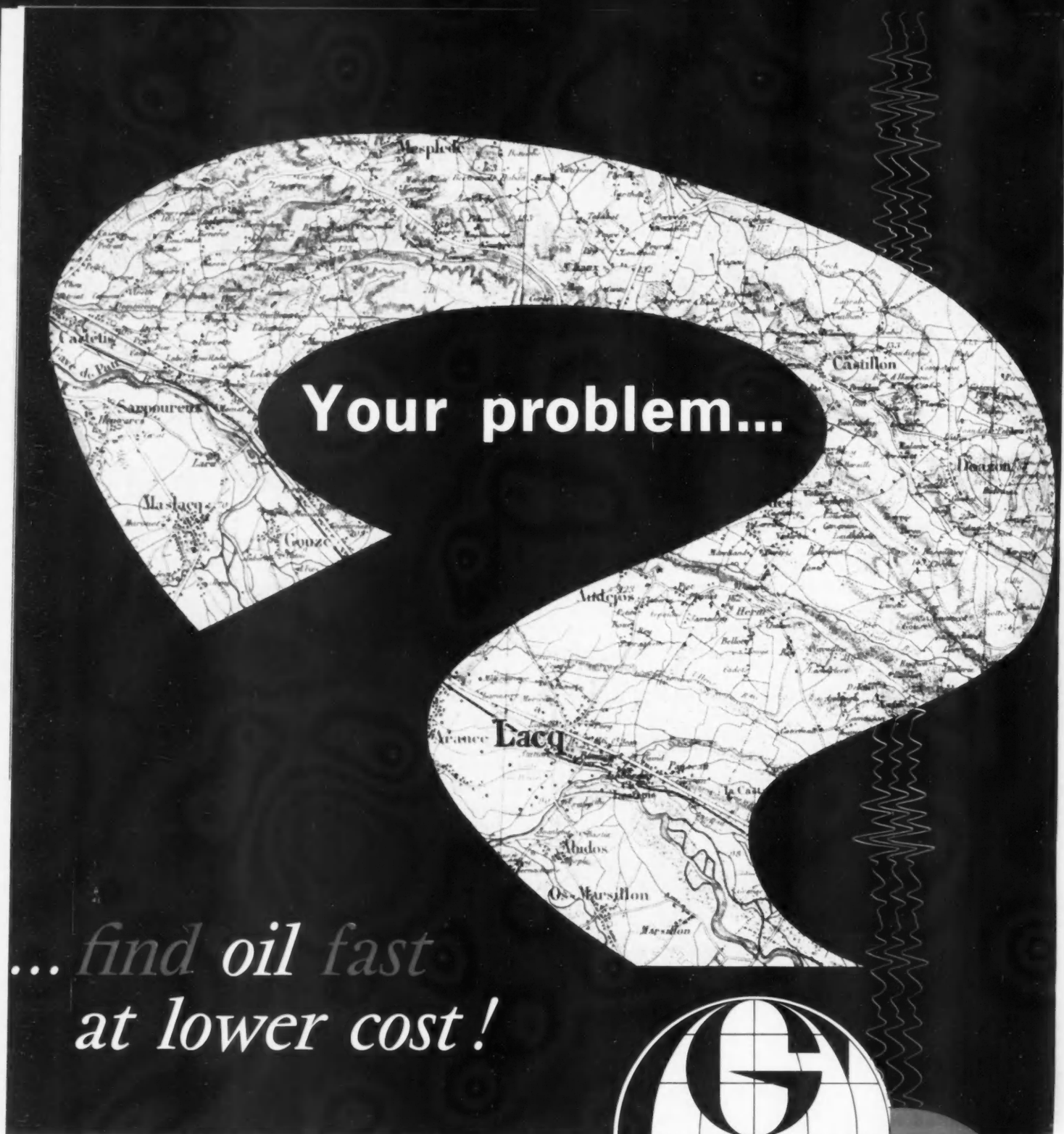
Large countries might well determine in advance whether conservation of offshore oil is better administered from a central government far removed from operations, or by nearby provincial government authorities. Since most subsurface minerals abroad are owned by the central governments, offshore ownership disputes will not occur in many countries. But conservation principles remain the same.

Current efforts in the U.N. to resolve, in effect, offshore oil problems in advance reflect U.S. experience. Problems related to the irregularity of cost lines are being worked out. As in the U.S., the coastal low water line is the starting point for measuring the breadth of the territorial sea.

An article adopted by the 1958 Convention on the Law of the Sea states that a bay shall be considered as internal waters if a line drawn across its mouth does not exceed 24 miles in length. If it does, the line is drawn within the bay where it *is* 24 miles across. Another article adopted in 1958 allows drawing a straight base line joining appropriate points in deeply indented coastlines (e.g., Chile), under specified conditions.

These efforts parallel the establishment of the "Chapman line" in Louisiana in 1950, and current efforts by state and federal geodesists to determine a permanent base line for administrative purposes along the Louisiana coast. This coast is being built seaward by rapid silting in many places, and is being eroded away at a noticeable rate elsewhere. The geodetic base line will be very important in such archipelago nations as Indonesia and the Philippines, since vast areas of deep ocean could be enclosed by expediently-drawn base lines.

The Supreme Court decision of May 31, settling the ownership dispute over immediate offshore U.S. areas, resolves, in this context, simply one of the world's many problems concerning development of the continental shelves. Due in large measure to the international nature and spirit of the shipping and fishing industries, the oil industry is off to a good start offshore.



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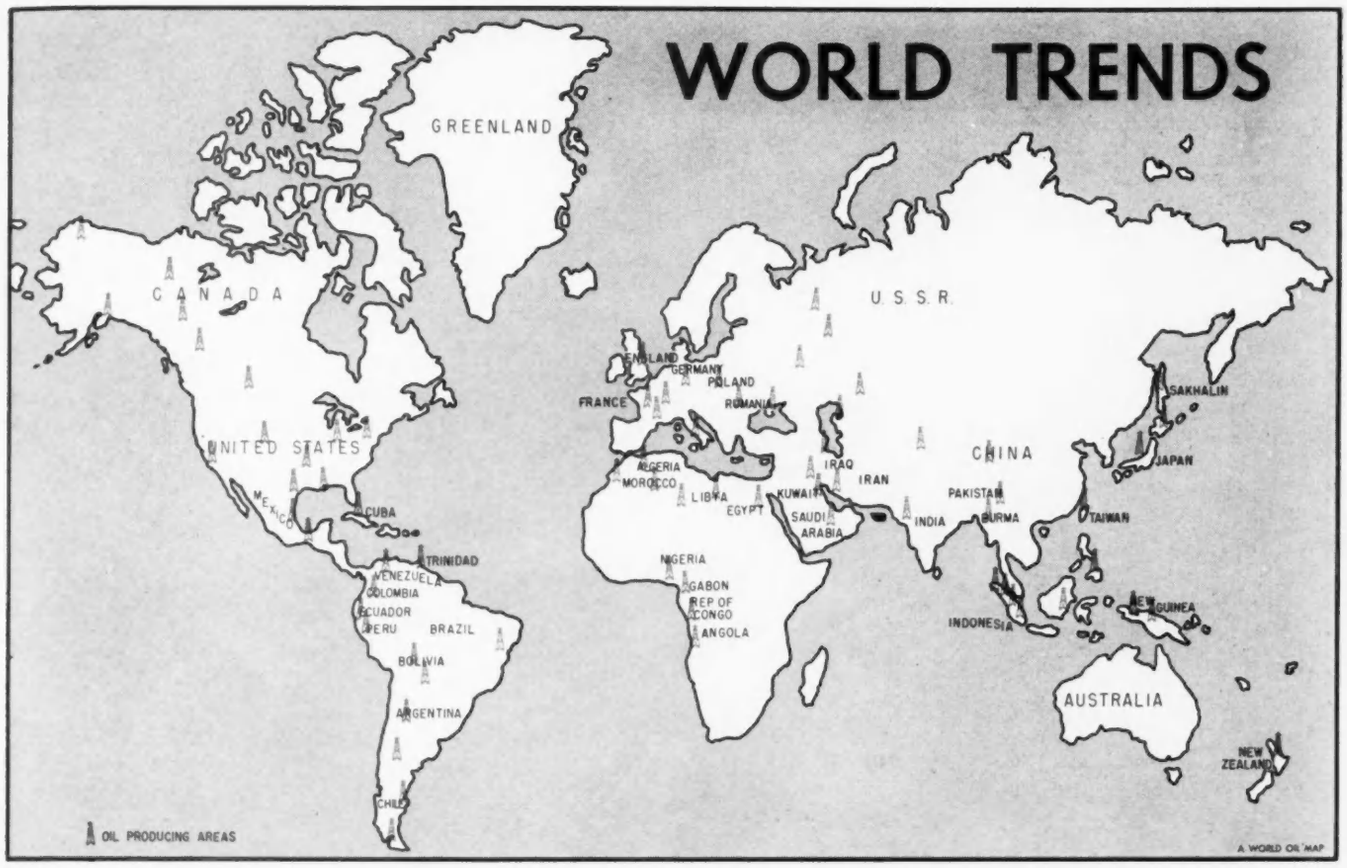


Oil operations vigorous throughout world

PETROLEUM INDUSTRY operations throughout the world continue generally vigorous. The world is now consuming over 20 million barrels of oil per day, and use is increasing steadily by about one million bpd.

Crude oil production readily meets the requirements. It rose in 1959 by 1.4 million barrels or 7.7% to 19.5 million bpd. Backing up the production are record crude reserves of 256 billion barrels.

Because of vast oil producing ability, both exploration and drilling have been somewhat curtailed for the world as a whole. But outside the U. S. and Canada, total drilling is increasing.

North America. Canada and Mexico continue active expansion of their oil and gas industries. The oil industry of the United States is becoming more optimistic than heretofore, as there is some success in achieving a better balance of supply with demand.

Canada will again increase production of oil and gas this year, after setting new records in 1959. Mexico has in progress a continuing program of expansion of both oil and gas development. The latter half of this year is expected to bring some revival in drilling in the United States.

Central America-West Indies. Exploration is lagging in these Caribbean areas, due to scarcity of discoveries and the reduced interest in finding new fields while the world surplus of crude oil persists. Trinidad still has active field development, but Cuba now is inactive.

South America. Venezuela remains a highly important oil producing country. The revived oil development in Argentina is showing good results. Brazil has expanded exploration, and is boosting production in the proved fields. Chile is actively developing good fields in the Straits of Magellan area. Colombia has been gaining new operators.

Europe. Western Europe has strong demand for petroleum to fuel its vigorous economies, and is actively developing its own petroleum possibilities in order to hold down the need for Middle East and other imported oils. In Eastern Europe, Russia is expanding oil and gas development and increasing its exports.

Africa. Prolific new fields have put North Africa in the spotlight. Exploration and drilling have increased sharply and will further expand, along with production and pipe line construction.

Middle East. The fabulous fields of the Middle East increasingly dominate world oil markets. Production steadily rises, and new fields still come easy and rich. Reserves are huge and still increasing.

Far East. The Oriental nations need oil of their own and are determined to find and develop it. They are carrying on vigorous and successful programs toward this end.

Oceania. A highlight of the past year was the first commercial oil discovery in the Phillipines. The East Indies islands have had new discoveries, and production is increasing. The urgent search for the first commercial oil in Australia continues.

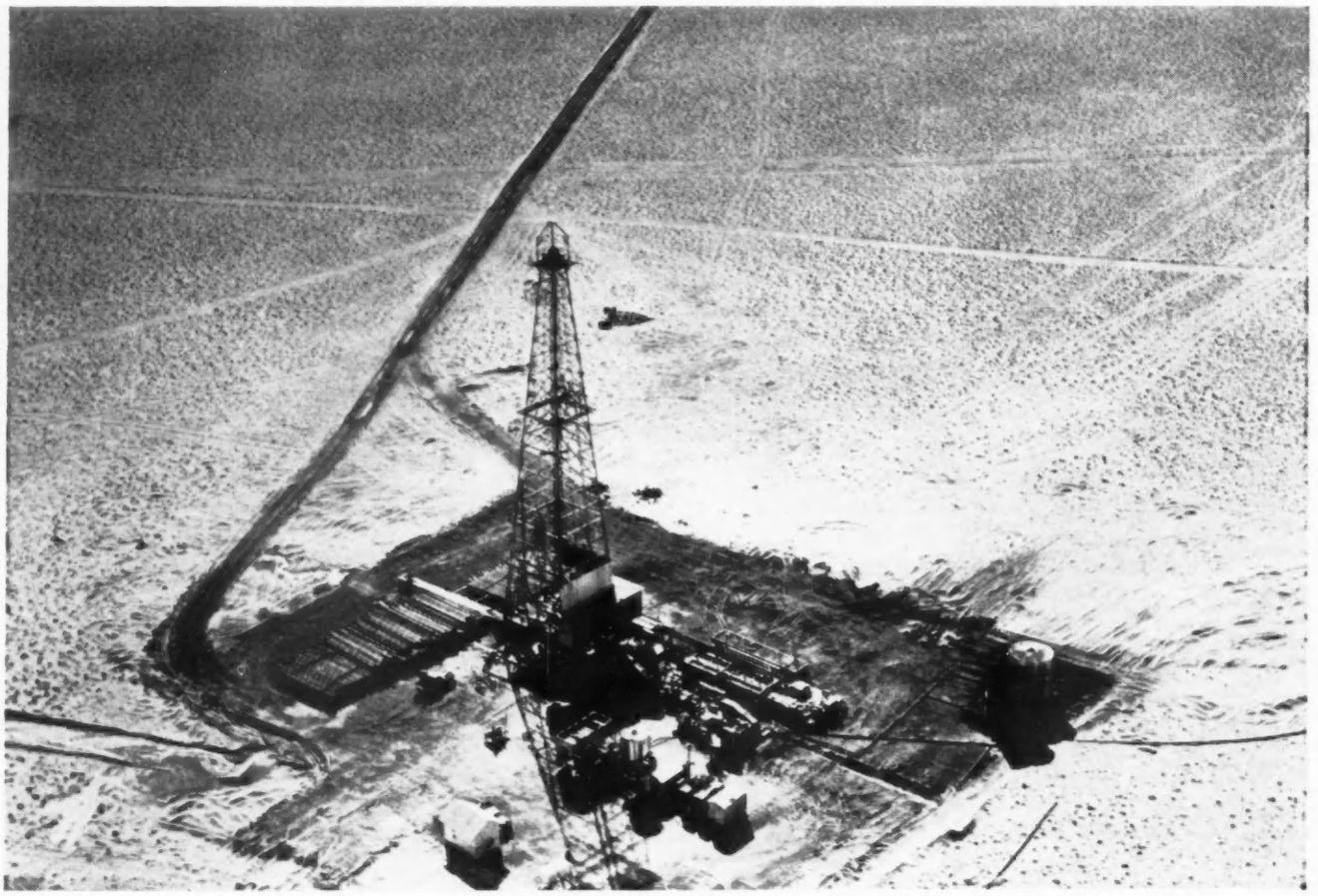


Photo by courtesy of The British Petroleum Co. Ltd.

DRILLING ON THE DESERT IN THE MIDDLE EAST

Drilling operations in north Kuwait have been accelerated in recent years, following discovery of the important new Raudhatain oil field in 1955, and completion of oil wells at Sabriya 1 and Bahra 2 about two years later.

Kuwait Oil Co. Ltd. has carried on vigorous drilling at Raudhatain in order to put the field on production in 1960. The flat, barren, open country enables crews to skid rigs very readily, sometimes over long distances.

Wells in the Cretaceous sand trend of north Kuwait and southern Iraq are generally drilled to about 10,000 feet.

World drilling . . . vigorous work will boost completions outside U.S. and Canada 7% in 1960

In the Free World outside the United States and Canada, vigorous drilling is expected to result in 5,403 well completions in 1960, an increase of 360 or 7.1 percent over the 5,043 of 1959. Continued active drilling in those areas in future years also is foreseen.

U.S. statistics continue to dominate the world drilling picture, however, and U.S. completions are expected to decline to 46,324 in 1960 from 49,331 in 1959, a drop of 3,007 wells or 6.1 percent. Canada also is expected to suffer a decrease in completions, to only 2,620 from 2,856, down 236 wells or 8.3 percent. Consequently, only 54,347 completions are expected in the whole Free World, against 57,230 in 1959, a decline of 2,883 wells or 5 percent.

Outside U.S. and Canada. In Mexico, Petroleos Mexicanos (Pemex) completed more than 300 wells in the first half of 1960, and expects to complete over 600 this year. There is a virtual shutdown in Cuba, and drilling is generally quiet in Central America and the West Indies outside Trinidad. Drilling in Trinidad is expected to remain vigorous, and 300 completions are expected this year, up 22 from the 278 of 1959.

In South America, well completions are expected to increase slightly, to 1,994 this year from 1,949 in 1959. In Argentina they are expected to rise 188, to 765 from 577. But Argentina's drilling boom will be moderated in the future, as fuel needs are nearly being met by domestic crude oil and natural gas. Drilling in Venezuela continues to decline and completions are expected to drop to 440 in 1960 from 707 in 1959.

In Western Europe, drilling may decline very slightly this year. Only 220 wells were completed in West Germany in the first half of 1960, and 460 are expected this year. In other recent years, West German completions have consistently exceeded 500 annually.

Africa. The drilling boom in Africa continues. This year, 511 completions are predicted, up 106 from 405 in 1959. In Libya, 100 completions are forecast; 32 rigs were active in April

1960. More completions are expected in Algeria and Nigeria and drilling is starting in the Spanish Sahara. But drilling is leveling off in Gabon.

In the Middle East, drilling rates are expected to remain about the same in 1960 as in 1959. Increases are expected in Iraq, Iran, Syria and the Neutral Zone. A decrease is expected in Kuwait from 50 wells in 1959 to 25 in 1960.

The drilling outlook is generally bright in the Far East. There were 182 completions in Japan in the first half of 1960, and 375 are expected this year. Activity is quickening in India, due to important new oil discoveries in Cambay.

Drilling in Free World Outside U. S. and Canada Expected to Increase in 1960

COUNTRY (Not Including Communist Countries)	Forecast For 1960		Wells Completed in 1959							Wells Completed In 1958		Wells Drilling at End of 1959
	Wells	% Diff. 1960–1959	Total Wells	Oil	Gas	Dry	Other	Total Footage	Average Depth	Wells	Footage	
N. America, excl. U. S	**3,240**	**— 1.7**	**3,297**	**1,761**	**437**	**1,099**		**16,310,895**	**4,947**	**3,335**	**16,328,647**	**351**
Canada	2,620	— 8.3	2,856	1,470	395	991		13,208,460	4,625	2,956	13,692,551	255
Mexico	620	+ 40.6	441	291*	42*	108*		3,102,435	7,035	379	2,636,096	96
Central America	**7**		**7**			**6**	1†	**51,027**	**7,290**	**12**	**71,104**	**3**
British Honduras	1	— 50.0	2			2		18,622	9,311	6	41,439	
Costa Rica	3	+200.0	1			1		6,775	6,775	1	4,400	2
Guatemala	1	— 66.7	3			3		18,683	6,228	1	6,000	1
Honduras	2	+100.0	1				1†	6,947	6,947			
Panama										4	19,265	
West Indies	**304**	**+ 3.8**	**293**	**247**	**3**	**43**		**1,511,861**	**5,160**	**359**	**1,551,901**	**31**
Bahamas		—100.0	1			1		18,906	18,906	1	18,906	
Barbados		—100.0	1			1		15,077	15,077			
Cuba		—100.0	13	3		10		26,006*	2,000	61	145,036	1
Trinidad	300	+ 7.9	278	244	3	31		1,446,586	5,204	295	1,365,129	29
Miscellaneous	4							5,292		2	22,830	1
South America	**1,994**	**+ 2.3**	**1,949**	**1,398**	**40**	**501**	**10‡**	**12,766,235**	**6,550**	**2,190**	**13,822,069**	**250**
Argentina	765	+ 32.6	577	476	13	88		3,303,753	5,726	390	2,021,503	97
Bolivia	30		30	21	1	8		189,670	6,322	36	158,057	19
Brazil	248	+ 8.3	229	128		101		940,372	4,106	140	688,698	30
Chile	100	+ 11.1	90	26	15	49		620,412	6,893	74	494,134	5
Colombia	230	+ 5.0	219	118	3	98		1,205,382	5,504	174	948,231	22
Ecuador	41	+ 41.4	29	21		8		105,965	3,654	42	116,905	5
Paraguay		—100.0	3			3		25,167	8,389	1	5,668	
Peru	140	+115.4	65	56		9		284,200	4,372	138	573,741	11
Venezuela	440	— 37.8	707	552	8	137	10‡	6,091,314	8,616	1,195	8,815,132	61
Western Europe	**1,073**	**— 2.5**	**1,100**	**439**	**92**	**479**	**90**	**5,948,609**	**5,408**	**1,073**	**6,146,952**	**189**
Austria	100	+ 22.0	82				82†	356,185	4,344	93	467,214	
Denmark		—100.0	2			2		17,766	8,883	9	52,266	
France	200	— 0.5	201	59	13	129		1,418,783	7,059	184	1,449,155	32
Germany, West	460	— 9.5	508	314	25	169		2,470,025	4,862	534	2,566,638	105
Great Britain	40	+ 14.3	35	16	1	12	6‡	135,613	3,875	27	95,403	4
Italy	180	+ 8.4	166	13*	50*	103		803,918	4,843	121	848,377	40
Malta		—100.0	1			1		9,736	9,736			40
Sicily	28	— 30.0	40	20		20		369,150	9,229	42	357,809	2
Netherlands	40	+ 5.3	38	17	3	16	2‡	220,663	5,807	42	183,323	2
Portugal		—100.0	8			8		31,770	3,971	5	32,767	
Spain	22	+ 15.8	19			19		115,000	6,053	14	85,000	4
Miscellaneous	3									2	9,000	
Africa, Northern	**350**	**+ 40.0**	**250**	**166**	**13**	**71**		**1,652,893**	**6,612**	**177**	**1,108,748**	**70**
Algeria	170	+ 14.1	149	115	9	25		1,028,031	6,900	110	674,626	30
Egypt	55	+ 77.4	31	29		2		184,964	5,967	21	172,912	11
Libya	100	+132.6	43	14	3	26		343,321	7,984	28	157,000	28
Morocco	20	— 9.1	22	8	1	13		73,545	3,343	13	66,344	1
Spanish Sahara	4											
Tunisia	1	— 80.0	5			5		23,032	4,606	5	37,860	
Africa, Other	**169**	**+ 9.0**	**155**	**57**	**7**	**91**		**1,136,375**	**7,331**	**168**	**1,034,159**	**24**
Angola	20	+ 25.0	16	8		8		132,500	8,281	9	66,178	4
Congo Republic	8	— 33.3	12	4	3	5		63,454	5,288	54	54,527	1
Gabon	50	+ 19.0	42	19	1	22		192,981	4,595	42	390,956	4
Nigeria	60	+ 13.2	53	25	3	25		537,387	10,139	32	320,976	8
Miscellaneous	31	— 3.1	32	1		31		210,053	6,564	31	201,522	7
Middle East	**215**	**— 0.9**	**217**	**145**	**3**	**62**	**7‡**	**1,202,810**	**5,543**	**192**	**1,158,839**	**48**
Abu Dhabi	2		2	2				16,720	8,360			
Bahrain		—100.0	1			1		7,675	7,675	3	5,535	
Dhofar	4	— 50.0	8			8		38,000*	4,750			2
Iran	20	+ 33.3	15	14		1		173,641	11,576	17	144,209	13
Iraq	35	+ 52.2	23	11		8	4‡	138,459	6,020	13	88,529	11
Israel	15	+ 66.7	9	2	3	4		55,615	6,179	9	42,244	2
Jordan	1	— 66.7	3			3		17,250	5,750			
Kuwait	25	— 50.0	50	48		1	1‡	222,254	4,445	40	314,565	2
Neutral Zone	60	+ 46.3	41	41				109,717	2,676	49	102,424	3
Oman	1		1			1		12,661	12,661			1
Qatar	2	+100.0	1			1		13,261	13,261	3	18,070	
Saudi Arabia	15	— 31.8	22	11		9	2‡	141,490	6,431	23	159,347	3
Syria	10	+ 66.7	6	3		3		48,000	8,000	6	38,500	2
Trucial Coast	2	+100.0	1			1		10,585	10,585			1
Turkey	22	— 35.3	34	13		21		197,482	5,808	22	158,545	8
Miscellaneous	1									7	86,871	
Asia, Far East	**471**	**+ 21.4**	**388**	**126**	**164**	**98**		**1,625,346**	**4,189**	**349**	**1,259,263**	**63**
Afghanistan	2	+100.0	1			1		7,000*	7,000*			1
Burma	35	+ 9.4	32	20*	1*	11		122,700	3,834	26	60,196	4
India	35	+ 66.7	21	14	2	5		206,325	9,825	19	178,000	5
Japan	375	+ 18.3	317	87	158	72		1,160,773	3,662	269	867,206	42
Pakistan	15	+ 66.7	9	1	3	5		87,048	9,672	18	100,000	4
Taiwan	6	+ 20.0	5	1		4		39,000	7,800	8	42,061	7
Thailand	3		3	3				2,500*	833	8	6,800	
Miscellaneous										1	5,000	
Oceania	**200**	**— 17.7**	**243**	**135**	**1**	**107**		**807,954**	**3,325**	**251**	**788,571**	**24**
Australia (Incl. Papua)	21	— 61.1	54			54		121,468	2,249	31	106,476	6
Philippines	21	+ 40.0	15	2		13		72,828	4,855			4
British Borneo (Sarawak & Brunei)	25		25	20		5		150,197	6,008	41	203,406	4
New Zeland	2	+100.0	1			1		13,040	13,040			4
Indonesia	130	— 8.5	142	113	1	28		420,403	2,961	172	440,066	2
Timor (Portuguese)	1	— 50.0	2			2		11,355	5,678			8
West New Guinea		—100.0	4			4		18,663	4,666	5	19,523	
Miscellaneous										2	19,100	
Sub-Total	**8,023**	**+ 1.6**	**7,899**	**4,474**	**760**	**2,557**	**108**	**43,014,005**	**5,446**	**8,106**	**43,270,247**	**1,053**
United States	**46,324**	**— 6.1**	**49,331**	**24,617**	**4,938**	**18,668**	**1,108‡**	**205,698,272**	**4,170**	**48,670**	**195,083,688**	**4,094**
Total, Free World	**54,347**	**— 5.0**	**57,230**	**29,091**	**5,698**	**21,225**	**1,216**	**248,712,277**	**4,346**	**56,776**	**238,353,935**	**5,147**

* Estimate. † Results unknown. ‡Service wells (water input, gas injection, etc.).

World crude reserves

Africa's reserves were increased

World demand and supply . . .

need for oil rising about 1 million barrels daily each year

WORLDWIDE DEMAND for crude oil, natural gasoline and lease condensates increased by 1,253,000 barrels daily in 1959 over 1958. This boosted the 1959 total to 20,473,000 barrels per day, 6.5 percent more than the 1958 figure. Most oil company forecasts anticipate annual rises of about equal magnitude in near future years. As previously predicted, the 1959 demand exceeded 20 million barrels for the first time.

Supply exceeded demand last year by 117,500 barrels daily, in contrast to 1958 when overstocks evidently built up during the previous three years were being worked off. Worldwide crude oil oversupply is becoming a chronic problem, depressing crude prices and intensifying competition for markets. Government officials in Saudi Arabia and Venezuela are now proposing international prorationing to apply to major oil-exporting nations.

United States and Canada. Excess demand over supply in the United States in 1959 amounted to 1,518,000 barrels daily, representing a 41,000 barrels daily decline from the 1958 figure. The mandatory imports control program evidently was responsible for the increased proportion of domestic crude and condensates to demand. At the same time, excess supply over demand in Canada increased by 13,600 barrels daily to 306,900 barrels a day.

Looking ahead, many factors must be considered in forecasting future worldwide supply-demand trends.

Demand. Since oversupply conditions are expected to persist for at least six years, continued deterioration of prices is feared. However, price-cutting may stimulate demand above previous forecasts based on higher prices. It may be significant that none of the European Common Market countries are now seriously considering development of a nuclear power industry. The superabundance of conventional fuels at low prices has dampened post-World War II and post-Suez enthusiasm for nuclear fuels development.

Development of the European Common Market is proceeding well, and appears to be stimulating petroleum demand through encouragement of rapid industrial development.

Supply. The effect of Sahara crude oil and natural gas on European markets is not yet clear. Estimates of future production from Hassi-Messaoud field in Algeria are being downgraded owing to poor reservoir characteristics of the pay formation. Anticipated Algerian output is 100,000 barrels daily in 1960 and 300,000 barrels daily in 1962. Producibility of new Libyan fields is not yet known. The effect of Sahara gas awaits commercial and/or technological breakthroughs in either methane liquefaction and transport or deep submarine pipelining.

Russian Exports. Excess supply over demand in the USSR increased from 262,000 barrels daily in 1958 to 403,000 in 1959. Russian planners obviously intend to push oil as an export "cash crop." Two schools of thought have developed regarding Russian oil exports.

The first is subscribed to by most oil company spokesmen who say that the primary purpose in Russian exports is to make money, and that Russia will cut prices as may be necessary to get and hold new markets.

The other theory is that Russia intends to precipitate an economic crisis in the Free World, and will use any method of trading (cash or barter) to accomplish it.

World Petroleum Demand and Supply, by Regions, for Years 1959 and 1958

Source: All data from private sources. Crude oil production figures may differ from those in other tables in this issue, which are from U.S. Bureau of Mines and other sources. But such differences are inconsequential.

THOUSANDS OF BARRELS PER DAY

REGION	Domestic Demand	Domestic Supply: Crude Oil	Domestic Supply: Natural Gasoline, Etc.	Domestic Supply: Total	Excess Supply Over Demand	Excess Demand Over Supply	% of World: Domestic Demand	% of World: Domestic Supply
1959								
North America	**10,557.0**	**7,823.3**	**905.7**	**8,729.0**	.....	**1,828.0**	**51.6**	**42.3**
United States	9,451.0[1]	7,054.0	879.0	7,933.0	.....	1,518.0	46.2	38.4
Canada	824.0	502.1	15.0	517.1	.....	306.9	4.0	2.5
Other N. America	282.0	267.2	11.7	278.9	.....	3.1	1.4	1.4
South America	**1,237.4**	**3,299.3**	**29.7**	**3,329.0**	**2,091.6**	.....	**6.0**	**16.1**
Venezuela	159.2	2,770.6	14.0	2,784.6	2,625.4	.....	0.8	13.5
Other Caribbean	204.6	258.1	5.7	263.8	59.2	.....	1.0	1.3
Other S. America	873.6	270.6	10.0	280.6	.....	593.0	4.2	1.3
Europe excl. USSR	**4,037.9**	**539.4**	**93.2**	**632.6**	.....	**3,405.3**	**19.7**	**3.0**
U.S.S.R.	**2,235.0**	**2,580.0**	**58.0**	**2,638.0**	**403.0**	.....	**10.9**	**12.8**
Africa	**483.0**	**110.1**	**6.5**	**116.6**	.....	**366.4**	**2.4**	**0.6**
Middle East	**482.3**	**4,599.5**	.....	**4,599.5**	**4,117.2**	.....	**2.4**	**22.3**
Far East; Oceania	**1,440.4**	**600.2**	**5.0**	**605.2**	.....	**835.2**	**7.0**	**2.9**
Total, World	**20,473.0**	**19,551.8**	**1,098.1**	**20,649.9**	**176.9**	.....	**100.0**	**100.0**
1958								
North America	**10,101.2**	**7,422.4**	**810.7**	**8,233.1**	.....	**1,868.1**	**52.5**	**43.1**
United States	9,065.0[1]	6,709.0	797.0	7,506.0	.....	1,559.0	47.1	39.3
Canada	753.7	452.7	7.7	460.4	.....	293.3	3.9	2.4
Other N. America	282.5	260.7	6.0	266.7	.....	15.8	1.5	1.4
South America	**1,207.5**	**3,071.1**	**26.8**	**3,097.9**	**1,890.4**	.....	**6.3**	**16.2**
Venezuela	162.0	2,605.8	13.3	2,619.1	2,457.1	.....	0.9	13.7
Other Caribbean	196.9	229.7	5.6	235.3	38.4	.....	1.0	1.2
Other S. America	848.6	235.6	7.9	243.5	.....	605.1	4.4	1.3
Europe excl. USSR	**3,669.5**	**534.4**	**103.3**	**637.7**	.....	**3,031.8**	**19.1**	**3.3**
U.S.S.R.	**1,994.0**	**2,200.0**	**56.0**	**2,256.0**	**262.0**	.....	**10.4**	**11.8**
Africa	**465.4**	**86.1**	**6.0**	**92.1**	.....	**373.0**	**2.4**	**0.5**
Middle East	**460.9**	**4,269.7**	.....	**4,269.7**	**3,808.8**	.....	**2.4**	**22.4**
Far East; Oceania	**1,321.5**	**511.0**	**5.0**	**516.0**	.....	**805.5**	**6.9**	**2.7**
Total, World	**19,220.0**	**18,094.7**	**1,007.8**	**19,102.5**	.....	**117.5**	**100.0**	**100.0**

[1] U.S. demand: 1959, includes Alaska and Hawaii; 1958, excludes Alaska and Hawaii.

World crude reserves . . . rise in

1959 by 11 billion barrels to new high of 256 billion

WORLD CRUDE OIL RESERVES continue to increase, and to become more diversified geographically. The total of 255,887,171,000 barrels estimated for the end of 1959 was 11,005,370,000 or 4.5 percent higher than the 244,881,801,000 barrels computed in revised figures for the end of 1958.

Crude oil reserves of the Middle East were put at 157,946,000,000 barrels at the end of 1959. This was a moderate 3.2 percent increase over the 153,096,000,000 barrels estimated at the end of 1958. The Middle East held 61.7 percent of the world total at the end of 1959.

At the same time, Communist countries held 24,668,500,000 barrels of crude reserves, or 9.6 percent of the world total.

Kuwait continued to lead the world in reserves, with 60 billion barrels at the end of 1959. Saudi Arabia increased its second-place position by advancing to 48 billion barrels. The United States increased its crude reserves to an all-time high of 31,719,347,000 barrels. Russia is considered to have 23 billion barrels of proved reserves, about equal to those of Iraq. Re-evaluations of Iran's oil reservoirs has caused figures to be lowered to 22 billion barrels.

Iranian reserves have been difficult to evaluate. South Iranian reservoirs in the Asmari limestone rely on fracture porosity and permeability. Shutting in of wells during the 1951-1954 nationalization threatened to be harmful, but apparently was not. On the basis of additional flush production data Agha Jari field has been appraised at about 7 billion barrels. Gachsaran field is evaluated at about 12 billion. These two fields comprise the bulk of Iran's crude reserves.

Iran's future is very bright, however. New discoveries at Binak and Ahwaz in south Iran, and the opening of an entire new oil province in central Iran by successes at Alborz and Sarajeh promise vast future reserves.

In south Iraq, Rumaila field has been greatly extended in recent years, and plans are to expand production.

Russia's crude oil reserves are put at 23 billion barrels in this study, as WORLD OIL this year renews its earlier policy of including Iron Curtain nations in the annual crude reserves study. However, reliable sources indicate that proved Soviet reserves may be as high as 26 billion barrels, close to those of the U. S. Crude reserves in Yugoslavia and Red China also are rising rapidly.

Africa's reserves were increased to 5,297,000,000 barrels at the end of 1959. Reserves in Libya, Algeria, and Nigeria were abruptly boosted last year. Further rapid increases in Libya and Nigeria may be expected within the next few years.

Venezuela's crude reserves were about the same at the end of 1959 as a year earlier. Near-record withdrawals were countered by some prolific new discoveries, particularly in Lake Maracaibo.

Proved Crude Oil Reserves in World Were Increased in 1959

Reserves estimated and production figures compiled by WORLD OIL, with aid of oil companies and other sources

CONTINENT AND COUNTRY	RESERVES, YEAR END (Thousand Barrels) 1959	1958	1959 As % of World	PRODUCTION In 1959 Thous. Barrels	As % of World	Ratio 1959 Reserves to Production
North America	**37,674,723**	**35,961,821**	**14.72**	**2,855,750**	**40.17**	**13.2**
Canada	3,497,124	3,165,904	1.37	184,767	2.60	18.9
Mexico	2,458,252	2,260,000	.96	96,393	1.36	12.5
United States	31,719,347	30,535,917	12.39	2,574,590	36.21	12.3
West Indies	**352,300**	**327,500**	**.14**	**41,114**	**.58**	**8.6**
Cuba	2,300	2,500	.....	195	.00	11.8
Trinidad	350,000	325,000	.14	40,919	.58	8.6
South America	**19,695,533**	**19,405,000**	**7.70**	**1,166,899**	**16.41**	**16.9**
Argentina	1,400,000	1,200,000	.55	48,221	.68	29.0
Bolivia	75,000	75,000	.03	3,170	.04	23.7
Brazil	260,000	250,000	.10	23,537	.33	11.0
Chile	75,000	55,000	.03	6,428	.09	11.7
Colombia	650,000	650,000	.25	53,574	.75	12.1
Ecuador	25,000	25,000	.01	2,823	.04	8.9
Peru	335,000	350,000	.13	17,726	.25	18.9
Venezuela	16,875,533	16,800,000	6.60	1,011,419	14.23	16.9
Western Europe	**1,367,010**	**1,326,000**	**.54**	**89,130**	**1.25**	**15.3**
Austria	210,000[1]	220,000	.08	16,946	.24	12.4
France	160,000	140,000	.07	11,713	.16	13.7
Germany, West	411,010	420,000	.16	36,230	.51	11.3
Italy	6,000	6,000	.00	657	.01	9.1
Sicily	350,000	335,000	.14	10,705	.15	32.7
Netherlands	225,000	200,000	.09	12,251	.17	18.4
United Kingdom	5,000	5,000	.00	628	.01	8.0
Eastern Europe	**24,268,500**	**23,212,500**	**9.48**	**1,023,463**	**14.39**	**23.7**
Albania	20,000	21,000	.01	3,201	.04	6.2
Bulgaria	15,000	13,000	.00	1,254	.02	12.0
Czechoslovakia	14,000	14,000	.00	834	.01	16.8
Germany, East	500	500	.00	N.A.	....	....
Hungary	150,000	145,000	.06	7,905	.11	19.0
Poland	19,000	19,000	.01	1,298	.02	14.6
Rumania	900,000	900,000	.35	85,347	1.20	10.5
Russia	23,000,000	22,000,000	8.99	919,435	12.93	25.0
Yugoslavia	150,000	100,000	.06	4,189	.06	35.8
Africa, Northern	**5,107,000**	**2,706,600**	**2.00**	**31,209**	**.44**	**163.6**
Algeria	3,000,000	2,000,000	1.17	9,191	.13	326.4
Egypt Region, UAR	600,000	500,000	.24	21,306	.30	28.2
Libya	1,500,000	200,000	.59	.....	....	....
Morocco	7,000	6,600	.00	712	.01	9.8
Africa, Southwestern	**190,000**	**90,000**	**.07**	**9,872**	**.14**	**19.2**
Angola	15,000	15,000	.01	358	.00	41.9
Gabon	63,000	59,000	.02	5,529	.08	11.4
Congo	2,000	1,000	.00	.....	....	....
Nigeria	110,000	15,000	.04	3,985	.06	27.6
Asia, Middle East	**157,946,000**	**153,096,000**	**61.72**	**1,679,473**	**23.62**	**94.0**
Abu Dhabi	50,000	.....	.02	.....	....	.....
Bahrain	170,000	170,000	.06	16,473	.23	10.3
Iran	22,000,000	21,500,000	8.60	338,810	4.77	64.9
Iraq	23,000,000	21,800,000	8.99	311,311	4.38	73.9
Israel	16,000	16,000	.01	913	.01	17.5
Kuwait	60,000,000	60,000,000	23.45	504,855	7.10	118.8
Neutral Zone	2,600,000	2,500,000	1.01	42,438	.60	61.3
Qatar	2,000,000	2,000,000	.78	62,197	.87	32.2
Saudi Arabia	48,000,000	45,000,000	18.76	399,821	5.62	120.0
Syria Region, UAR	50,000	50,000	.02	.....	....	....
Turkey	60,000	60,000	.02	2,655	.04	22.6
Asia, Far East	**850,075**	**773,350**	**.33**	**34,378**	**.48**	**24.7**
Burma	45,000	45,000	.02	3,892	.05	11.6
India	350,000	350,000	.14	3,548	.05	98.6
Pakistan	20,000	19,000	.01	2,094	.03	9.6
China	400,000	325,000	.15	21,900	.31	18.3
Japan	34,000	33,275	.01	2,856	.04	11.9
Taiwan (Formosa)	75	75	....	13	.00	5.8
Thailand	1,000	1,000	....	75	.00	13.3
Oceania	**8,436,030**	**7,983,030**	**3.30**	**178,990**	**2.52**	**47.1**
Australia	.....	.....	....	.....	....	....
Indonesia	8,000,000	7,500,000	3.13	137,253	1.93	58.2
New Zealand	30	30	....	4	....	7.5
Sarawak-Brunei	430,000	475,000	.17	40,072	.57	10.7
West New Guinea	6,000	8,000	.00	1,661	.02	3.6
Total	**255,887,171**	**244,881,801**	**100.0**	**7,110,278**	**100.0**	**36.0**

[1] Less than government figures mentioned in Austria article. Austrian production has been declining steadily for several years.

[2] Includes Asiatic Russia and Sakhalin Island.

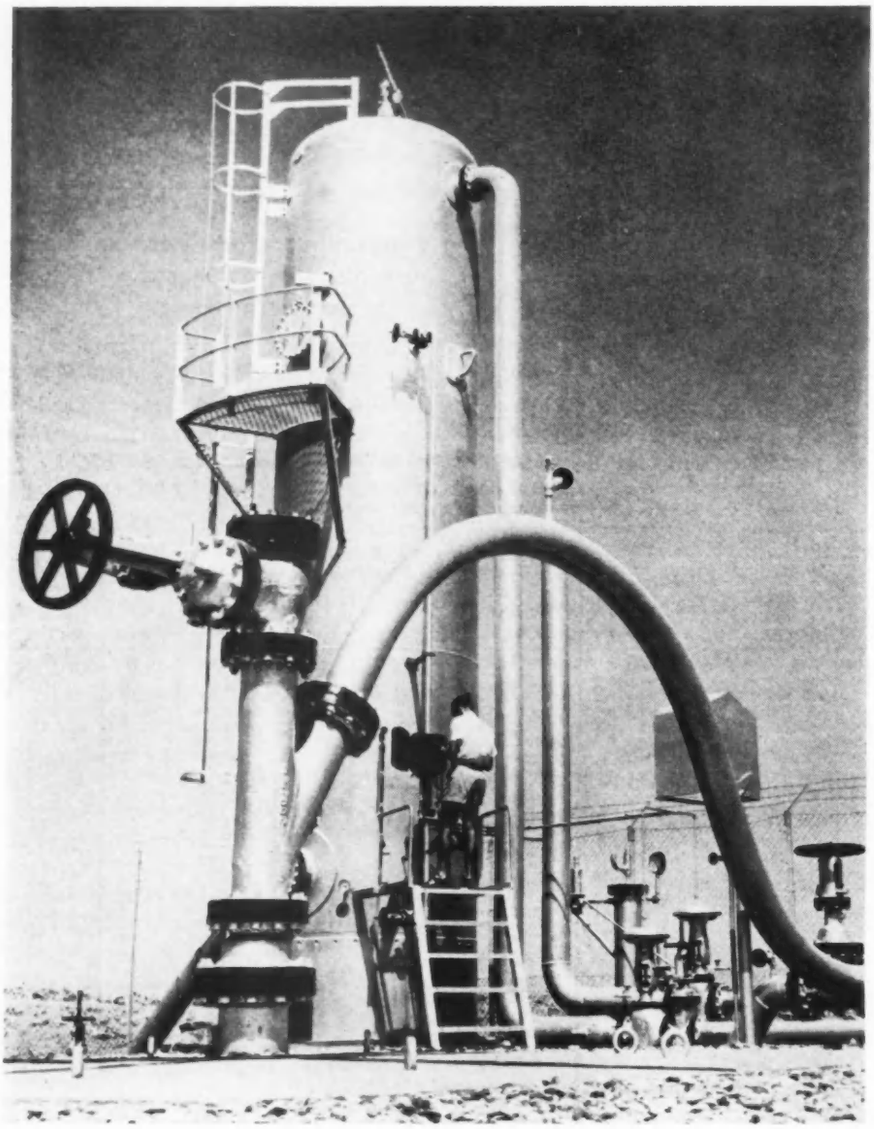


Photo shows the head of a prolific Middle East oil well in Kirkuk field in Iraq, and large vertical separators installed with it. Such wells produce about 10,000 bpd and are typical of Middle East production.

World crude production . . .

to rise 978,000 bpd or 5% to 20,458,000 bpd in 1960

WORLD CRUDE OIL PRODUCTION is expected to average 20,458,000 barrels daily in 1960. This will be the first year in history that production will exceed 20 million barrels a day. If fulfilled, this anticipated rate will represent a 5 percent increase over the 19,480,215 bpd rate of 1959. The 1959 yield was 7.7 percent higher than 1958 output of 18,090,947 barrels daily.

This year, crude output in the United States is expected to increase by 1.5 percent over the 1959 rate to 7,158,000 bpd. This forecast was made by the U. S. Bureau of Mines. Outside of the U. S., crude oil production is expected to increase by 7 percent above the 1959 rate to 13,300,000 bpd.

During the past decade and particularly during the past five years, many nations deficient in domestic crude oil production have made strong efforts to increase it. And countries with oil possibilities but without proven production have generally made vigorous efforts to find oil. Hence, production is being increased strongly in Argentina, Brazil, Chile, West Germany, The Netherlands, the French Community and Japan, among nations in which demand has exceeded domestic supply. Such nations as Nigeria, Israel and the Philippines have become crude oil producers in recent years.

In these countries, domestic demand tends to increase when domestic oil becomes available and also because foreign exchange problems may be eased as a result.

Although some leveling off may be expected in the output of the large oil-exporting nations, e.g. Venezuela and Kuwait, production in these countries is not being held back to a significant extent. Strong competition between producers has led to price-cutting, placing oil in a stronger competitive position relative to other fuels. Venezuela's oil output during the first half of 1960 was about equal to that during the same period in 1959. Saudi Arabia and Iran increased their production during the early months of 1960. Kuwait oil is assured of a steady outlet, since Royal Dutch Shell is obligated by long-term contract to purchase a large portion of it.

With the world's industrial activity constantly on the increase, the need for oil will continue to increase also in the foreseeable future. Since crude is in heavy oversupply at present, all pertinent factors point to new production records each year.

Percentagewise, the largest boosts in crude output are being made in

Crude Production Rising More Sharply Outside U.S. Than in U.S.

YEAR	WORLD		UNITED STATES		OUTSIDE U.S.	
	Barrels Daily	% Diff. from Prior Year	Barrels Daily	% Diff. from Prior Year	Barrels Daily	% Diff. from Prior Year
1951	11,733,507	+12.6	6,158,112	+13.9	5,575,395	+11.2
1952	12,380,093	+ 5.5	6,256,382	+ 1.6	6,123,711	+ 9.8
1953	13,145,356	+ 6.2	6,457,759	+ 3.2	6,687,597	+ 9.2
1954	13,744,775	+ 4.6	6,342,433	— 1.8	7,402,342	+10.7
1955	15,413,378	+12.1	6,806,652	+ 7.3	8,606,726	+16.3
1956	16,732,708	+ 8.6	7,151,046	+ 5.1	9,581,662	+11.3
1957	17,887,179	+ 6.9	7,169,592	+ 0.3	10,717,587	+11.8
1958	18,090,947	+ 1.1	6,709,553	— 6.4	11,381,394	+ 6.2
1959	19,480,215	+ 7.7	7,053,671	+ 5.1	12,426,544	+ 9.2
1960 Est.	20,458,000	+ 5.0	7,158,000	+ 1.5	13,300,000	+ 7.0

such areas as southwestern Africa, where production has just begun in recent years in Gabon, Nigeria, Angola and Congo. Strong increases also are being made in the Far East, long an oil-deficient area where domestic supplies are sorely needed as a basis for industrial development and to conserve foreign exchange.

Russia has made strong gains in recent years, as its emphasis on oil exploration since the end of World War II is showing positive results. The Soviets wish to base economic growth more strongly on oil and gas, to diversify oil sources geographically for internal consumption and national defense reasons, to provide an oil surplus for export, and to make eastern European satellite nations dependent on Russia for fuel.

World Crude Oil Production and Producing Wells, by Countries, 1959 and 1958, and Cumulative Production through 1959

(Sources: Annual data from private sources or estimates by WORLD OIL. Cumulative totals based on U.S. Bureau of Mines data.)

Continent and Country	Producing Oil Wells, End of 1959: Flowing	Art Lift	Total	End of 1958 Total	Annual Production (Barrels): 1959	1958	Daily Average Production (Barrels): 1959	1958	% Diff. 58-59	Year's Production As Percent of World: 1959	1958	Cumulative Production To January 1, 1960 (Barrels): Total	As % of World
North America	**73,979**	**516,832**	**590,811**	**594,115**	**2,855,750,686**	**2,715,132,320**	**7,823,974**	**7,438,718**	**+ 5.2**	**40.16**	**41.12**	**67,445,502,898**	**57.89**
Canada	4,373	9,629	14,002	17,384	184,767,642	165,503,916	506,213	453,435	+ 11.6	2.60	2.51	1,310,815,753	1.12
Mexico	1,481	813	2,294	2,211	96,393,044†	100,641,404†	264,090†	275,730†	— 4.2	1.35	1.52	3,262,331,745	2.80
United States	68,125	506,390	574,515	574,520	2,574,590,000	2,448,987,000	7,053,671	6,709,553	+ 5.1	36.21	37.09	62,872,355,400	53.97
West Indies	**890**	**2,581**	**3,471**	**3,515**	**41,113,633**	**37,698,591**	**112,640**	**103,284**	**+ 9.1**	**0.58**	**0.57**	**671,681,958**	**0.58**
Barbados												8,000	
Cuba		210	210	215	194,847	343,532	534	941	— 43.3	0.00	0.00	4,338,166	
Trinidad	890*	2,371*	3,261	3,300*	40,918,786	37,355,059	112,105	102,343	+ 9.5	0.58	0.57	667,335,792	0.58
South America	**4,216**	**17,346**	**21,562**	**21,440**	**1,166,899,071**	**1,083,444,030**	**3,196,984**	**2,968,340**	**+ 7.7**	**16.41**	**16.41**	**15,220,847,774**	**13.07**
Argentina	184*	3,620*	3,804*	3,699	48,221,081	35,697,187	132,112	97,801	+ 35.1	0.68	0.54	744,583,851	0.64
Bolivia	93	20	113	127	3,170,115	3,435,830	8,685	9,413	— 7.7	0.04	0.05	25,002,434	0.02
Brazil	285*	277*	562	175	23,537,430	18,923,738	64,486	51,846	+ 24.4	0.33	0.29	62,927,435	0.05
Chile	92	8	100	102	6,428,151	5,567,883	17,611	15,254	+ 15.5	0.09	0.09	27,744,847	0.02
Colombia	175*	1,902*	2,077	2,300	53,574,112	46,899,719	146,778	128,492	+ 14.2	0.75	0.71	892,398,617	0.77
Ecuador	55	1,536	1,591	1,548	2,822,955	3,108,497	7,734	8,516	— 9.2	0.04	0.05	76,904,221	0.07
Peru	312	2,592	2,904	3,114	17,725,847	18,732,136	48,564	51,321	— 5.4	0.25	0.28	558,473,495	0.48
Venezuela	3,020*	7,391*	10,411	10,375	1,011,419,380	951,079,040	2,771,012	2,605,696	+ 6.3	14.23	14.40	12,832,812,874	11.02
Western Europe	**742**	**4,335**	**5,077**	**5,594**	**89,129,906**	**82,991,155**	**244,192**	**227,373**	**+ 7.4**	**1.25**	**1.26**	**769,711,625**	**0.66**
Austria				903	16,945,855	19,548,411	46,427	53,557	— 13.3	0.24	0.30	254,266,787	0.22
France	45*	500*	545*	440	11,712,828	10,039,749	32,090	27,506	+ 16.7	0.16	0.15	73,257,718	0.06
Germany, West	560*	3,185*	3,745*	3,541	36,229,582	31,464,332	99,259	86,204	+ 15.1	0.51	0.48	307,133,365‡	0.27
Italy	25*	75*	100*	60	657,272	522,657	1,801	1,432	+ 25.8	0.01	0.01	40,167,984	0.03
Sicily	58		58	48	10,704,598	9,525,811	29,328	26,098	+ 12.4	0.15	0.14		
Netherlands	47	325	372	350	12,251,462	11,287,457	33,565	30,925	+ 8.5	0.17	0.17	85,731,370	0.07
United Kingdom	7	250	257	252	628,309	602,708	1,721	1,651	— 4.2	0.01	0.01	9,154,401	0.01
Eastern Europe				**41,480**	**1,023,462,740**	**906,583,077**	**2,804,008**	**2,483,789**	**+ 12.9**	**14.40**	**13.73**	**14,345,173,841**	**12.31**
Albania				300*	3,201,050	2,690,130	8,770	7,370	+ 9.0	0.05	0.04	34,932,792	0.03
Bulgaria				150*	1,253,775*	1,750,000	3,435*	4,795	— 28.4	0.02	0.03	7,597,775	0.00
Czechoslovakia				175*	834,025	813,400	2,285	2,228	+ 2.6	0.01	0.01	13,246,225	0.01
Germany, East				10		32,612		89				64,612‡	
Hungary				630*	7,905,000	6,325,270	21,657	17,330	+ 25.0	0.11	0.10	114,296,270	0.10
Poland				700*	1,297,575	1,298,325	3,555	3,557	— 0.1	0.02	0.02	292,316,447	0.25
Rumania				4,200*	85,347,575	84,487,000	233,555	231,471	+ 0.9	1.20	1.28	1,899,466,575	1.63
U.S.S.R. (Russia)				35,000*	919,435,000	805,920,000	2,519,000	2,208,000†	+ 14.1	12.93	12.20	11,961,623,000	10.27
Yugoslavia				315*	4,188,740	3,266,340	11,476	8,949	+ 28.2	0.06	0.05	21,630,145	0.02
Africa, Northern	**135**	**180**	**315**	**277**	**31,208,780**	**25,801,590**	**85,504**	**70,689**	**+ 21.0**	**0.44**	**0.39**	**322,555,742**	**0.28**
Algeria	50*	15*	65*	32	9,190,714	3,243,764	25,180	8,887	+ 83.3	0.13	0.05	15,095,172	0.01
Egypt	60*	100*	160*	160	21,305,742	21,997,988	58,372	60,268	— 3.2	0.30	0.33	300,267,770	0.26
Libya													
Morocco	25*	65*	90*	85*	712,324	559,838	1,952	1,534	+ 27.2	0.01	0.01	7,192,800	0.01
Africa, Southwestern	**118**	**20**	**138**	**99**	**9,872,037**	**5,774,572**	**27,047**	**15,821**	**+ 71.0**	**0.14**	**0.09**	**17,072,669**	**0.01**
Angola	12	2	14	13	357,983	360,118	981	987	— 0.6	0.00	0.01	853,686	
Gabon	80*	18*	98*	70	5,529,203	3,583,181	15,148	9,817	+ 54.3	0.07	0.05	10,393,899	0.01
Nigeria	26		26	16	3,984,851	1,831,273	15,782	5,017	+ 14.6	0.07	0.03	5,825,084	
Asia, Middle East	**1,087**	**106**	**1,193**	**1,104**	**1,679,473,274**	**1,558,507,552**	**4,601,297**	**4,269,884**	**+ 7.8**	**23.62**	**23.60**	**14,337,436,524**	**12.31**
Bahrain	148		148	147	16,473,378	14,873,111	45,132	40,748	+ 10.8	0.23	0.23	229,918,951	0.20
Iran	93		93	105	338,809,853	301,525,712	928,246	826,098	+ 12.4	4.77	4.57	3,769,303,643	3.24
Iraq	98	36	134	110	311,311,000	266,102,000	852,907	729,047	+ 17.0	4.38	4.03	2,361,265,000	2.03
Israel		24	24	23	912,500	650,000	2,500	1,781	+ 40.4	0.01	0.01	2,108,500	0.00
Kuwait	319		319	297	504,855,244	509,382,593	1,383,165	1,395,569	— 0.9	7.10	7.71	3,653,236,837	3.14
Neutral Zone	178		178	141	42,438,490	29,310,000	116,270	80,301	+ 44.8	0.60	0.44	121,475,490	0.10
Qatar	50		50	50	62,197,000	63,910,000	170,403	175,096	— 2.7	0.87	0.97	388,503,000	0.33
Saudi Arabia	201		201	195	399,820,590	370,485,585	1,095,399	1,015,029	+ 7.9	5.62	5.61	3,800,159,653	3.26
Turkey		46	46	36	2,655,219	2,268,551	7,275	6,215	— 17.1	0.04	0.03	11,465,450	0.01
Asia, Far East	**602**	**3,594**	**4,196**	**4,717**	**34,377,817**	**27,487,673**	**94,186**	**75,309**	**+ 25.1**	**0.48**	**0.41**	**689,845,038**	**0.59**
Burma	40*	354*	394*	240	3,892,200	3,394,500	10,664	9,300	+ 14.7	0.05	0.05		
India	30	520	550	550	3,547,800	3,139,000	9,720	8,600	+ 13.0	0.05	0.05	400,981,854	0.34
Pakistan	25	65	90	90	2,093,622	2,046,709	5,736	5,607	+ 2.3	0.03	0.03		
China				1,200*	21,900,000	16,279,000	60,000	44,600	+ 34.5	0.31	0.24	67,806,000	0.06
Japan	500	2,603	3,103	2,581	2,856,149	2,613,453	7,825	7,160	+ 9.3	0.04	0.04	119,251,654	0.10
Sakhalin§												101,240,000	0.09
Taiwan (Formosa)	7	27	34	34	13,046	15,011	36	41	— 12.2	0.00	0.00	490,530	
Thailand		25	25	22	75,000*		205*			0.00		75,000*	
Oceania	**557**	**2,153**	**2,710**	**2,724**	**178,990,497**	**159,774,978**	**490,385**	**437,740**	**+ 12.0**	**2.52**	**2.42**	**2,682,982,768**	**2.30**
Australia													
Indonesia	441	1,718	2,159	2,191	137,253,191	118,986,335	376,036	325,990	+ 15.4	1.93	1.80	2,090,621,747	1.79
New Zealand		4	4	4	4,500	4,571	12	13	— 7.7	0.00	0.00	116,957	
Sarawak-Brunei (Br. Borneo)	115	387	502	486	40,071,902	38,920,706	109,786	106,632	+ 3.0	0.57	0.59	567,526,351	0.49
West New Guinea	1	44	45	43	1,660,904	1,863,366	4,220	5,105	— 17.3	0.02	0.03	24,717,713	0.02
World, Undistributed												1,044,000	
Total, World‡	**82,326**	**547,147**	**629,473**	**675,065**	**7,110,278,441**	**6,603,195,528**	**19,480,215**	**18,090,947**	**+ 7.7**	**100.0**	**100.0**	**116,503,854,837**	**100.0**

* Estimate. † Mexico in 1958 included absorption liquids; figure for 1959 is crude oil only. Mexico in 1959 also produced 9,365,432 barrels or 25,659 barrels daily of natural gas liquids Total production of liquid hydrocarbons in 1959 was 105,758,476 barrels or 289,749 barrels daily, an increase of 5.1 percent over 1958 output of 100,641,404 barrels or 275,730 barrels daily. ‡ East Germany prior to 1957 was included with West Germany. § Sakhalin is included with U.S.S.R. in Europe after 1951. ‡ Producing oil wells at end of 1959 do not include Communist Countries.

TABLE 1—There Were Fewer Crew-Months of Geophysical Exploration for Petroleum in World in 1959 Than in 1958

Source: The 1959 Geophysical Activity Report of the Society of Exploration Geophysicists

METHOD	U. S. A.			Canada			Western Hemisphere			Eastern Hemisphere			World		
	1958	1959	% Diff.	1958	1959	% Diff.	1958	1959	% Diff.	1958	1959	% Diff.	1958	1959	% Diff.
Seismic	5,064	5,097	+0.65	1,065	796	—25.3	7,249	6,988	— 3.6	3,077	2,735	—12.5	10,326	9,723	— 5.8
Gravity	612	548	—10.5	65	41	—36.9	1,194	972	—18.6	670	517	—22.8	1,864	1,489	—20.1
Magnetic	55	51	—7.3	.....	1	+....	102	52	—49.0	124	109	—12.1	226	161	—28.8
Other	.....	.....	.....	.....	3	+....	2	3	+50.0	183	105	—42.6	185	108	—41.6
Total	5,731	5,696	—0.61	1,130	841	—25.6	8,547	8,015	— 5.1	4,054	3,466	—14.5	12,601	11,481	— 8.9

Geophysical activity . . . work by all methods shrinks further. Drop for seismic smallest

GEOPHYSICAL ACTIVITY in the Free World petroleum industry continued its downward trend in 1959, when 11,481 party-months were recorded. That was an 8.8 percent drop from the 12,590 crew-months of 1958. However, significant increases in seismograph activity occurred in the United States, Argentina and Africa. Also, there was a small over-all increase in geophysical activity in the Far East.

Several trends are evident in current geophysical prospecting for oil and gas:

- Geophysical crews are becoming more efficient. Improved equipment and instrumentation and increased use of aircraft for operational and logistical support have increased productivity, so that fewer crews are required to provide the same coverage.

- Improved instrumentation and interpretation have also encouraged the re-running of old geophysical data for reinterpretation in the light of increased subsurface data from more recent drilling, also reducing the need for new geophysical coverage.

- Some marginal areas of exploratory activity are being dropped in favor of specific prospects to be detailed. Reconnaissance methods (gravity, magnetic) are being used less, despite recent re-evaluation of, and interest in, the less expensive methods. For instance, in Africa, while seismic work increased from 829 party-months in 1958 to 1,019 in 1959, other geophysical activity there was reduced. A less-pronounced but similar trend was noted in the U.S. last year.

An encouraging note is the increase in seismic activity in the U. S. A total of 5,097 seismic crew-months was recorded in 1959, representing 33 crew-months or 0.65 percent increase from the 5,064 crew-months in 1958.

In 1957, there were 7,242 party-months of geophysical work in the U. S. compared with 5,731 in 1958 and 5,696 in 1959. The U. S. total accounted for 49.6 percent of the Free World's petroleum geophysical work in 1959.

In the United States in 1959, Texas accounted for 33.1 percent of the geophysical work, Louisiana 17.5 percent, and the Rocky Mountain states about 25 percent.

TABLE 2—Western Hemisphere in 1959 had 71.9% of World's Seismic Prospecting and 65.3% of Gravity Work

(Crew months of work and percent of world total for each area.)

Continent and Country	SEISMIC		GRAVITY	
	Crew Mos.	% of Total	Crew Mos.	% of Total
Western Hemisphere	**6,988**	**71.9**	**972**	**65.3**
North America	**6,150**	**63.3**	**651**	**43.7**
United States inc. Alaska	5,097	52.4	548	36.8
Canada	796	8.2	41	2.7
Mexico	204	2.1	60	4.0
Cent. America & West Indies	53	0.6	2	0.2
South America	**838**	**8.6**	**321**	**21.6**
Venezuela	73	0.8	29	1.9
Argentina	302	3.1	53	3.6
Colombia	99	1.0	.....	0.5
Bolivia	102	1.0	64	4.3
Brazil	187	1.9	130	8.7
Others	75	0.8	45	2.6
Eastern Hemisphere	**2,735**	**28.1**	**517**	**34.7**
Europe	**1,026**	**10.6**	**88**	**5.9**
Germany	456	4.7	27	1.8
France	182	1.9	16	1.1
Italy & Sicily	195	2.0	20	1.3
Others	193	2.0	25	1.7
Africa	**1,019**	**10.5**	**116**	**7.8**
Middle East	**355**	**3.6**	**115**	**7.7**
Far East	**335**	**3.4**	**198**	**13.3**
Total, World	**9,723**	**100.0**	**1,489**	**100.0**

Source of data: The 1959 Geophysical Activity Report of the Society of Exploration Geophysicists.

In South America, Argentina enjoyed 302 crew-months of seismic work in 1959 to take the lead in this line of activity. Brazil ranked second and Venezuela, long the leader in South America, dropped precipitously in seismograph activity to third place.

Seismic work was also reduced in Canada in 1959. A total of 796 party-months of seismic work was done last year, a drop of 25.3 percent from the 1,065 crew-month in 1958.

Western European geophysical activity declined in 1959. Total crew-months in West Germany decreased from 609 in 1958 to 512 last year, and in Metropolitan France from 464 in 1958 to 207 in 1959. Italy-Sicily replaced France as Free Europe's second nation in petroleum geophysical activity while sustaining a drop from 302 party-months in 1958 to 255 in 1959.

In the Middle East, geophysical activity declined in 1959 despite a slight increase in gravity work from 97 crew-months in 1958 to 115 in 1959. Historically, gravity has been very effective in the Middle East, perhaps more so than in any other oil province. However, this increase was insufficient to offset decreases in seismic and magnetic work.

In the Far East, important increases in geophysical activity occurred in India, where 162 crew-months were recorded in 1959 compared to only 25 in 1958; and in the Philippines, with 78 crew-months in 1959 against 60 in 1958. Those gains offset declines in Australia, Japan and Pakistan to give the area a slight net boost last year.

Over all, 69.8 percent of the geophysical work was done in the Western Hemisphere in 1959 and 30.2 percent in the Eastern Hemisphere.

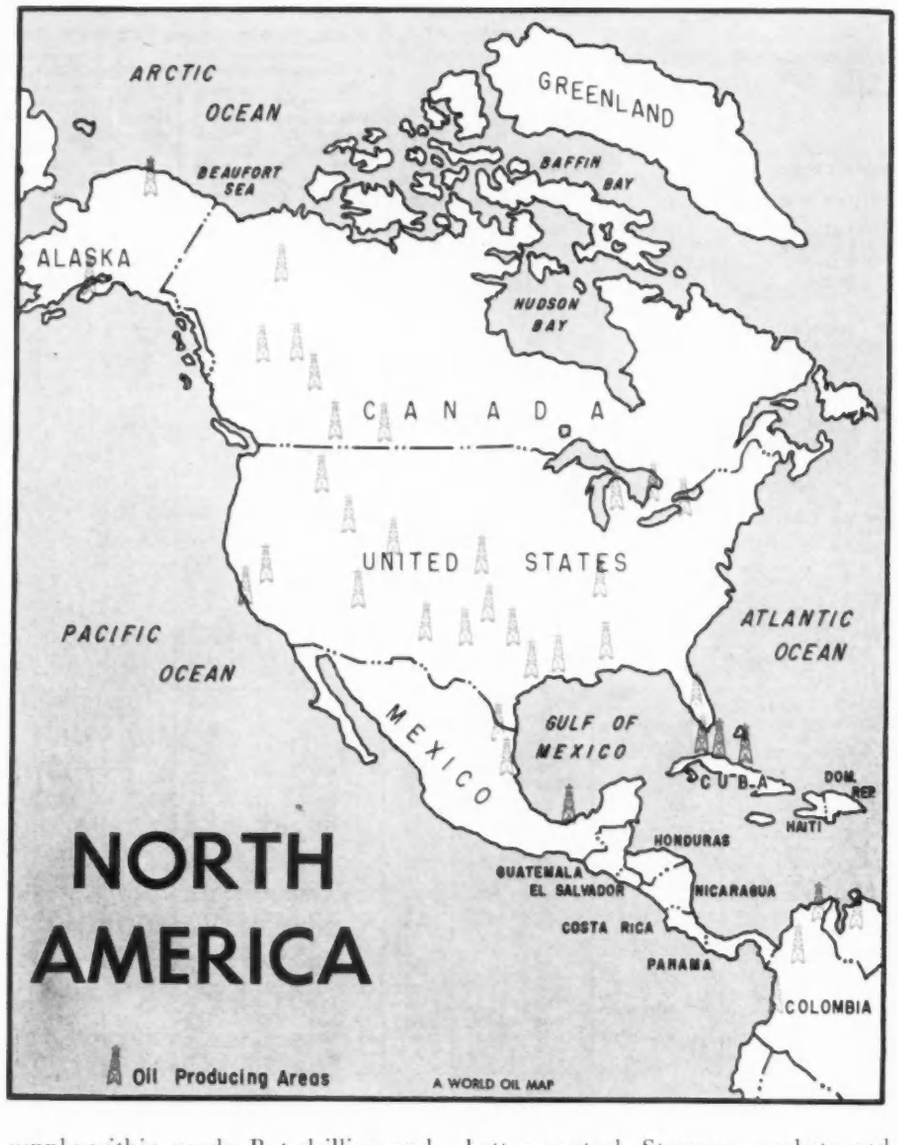
TABLE 3—Geophysical Crew-Months in Free World in 1959, by Countries

(Source: The 1959 Geophysical Activity Report of the Society of Exploration Geophysicists. The complete report will be published in December, 1959, in the society's magazine, *Geophysics*, Vol. 25, No. 6).

AREA	SEISMIC			GRAVITY			MAGNETIC			OTHER			ALL		
	Company	Contractor	Total	Company	Contractor	Total	Company	Contractor	Total	Company	Contractor	Total	Company	Contractor	Total
World Total	**3,606**	**6,117**	**9,723**	**559**	**930**	**1,489**	**36**	**125**	**161**	.....	**108**	**108**	**4,201**	**7,280**	**11,481**
Western Hemisphere	**3,042**	**3,946**	**6,988**	**493**	**479**	**972**	**35**	**17**	**52**	.....	**3**	**3**	**3,570**	**4,445**	**8,015**
South America	**345**	**493**	**838**	**224**	**97**	**321**	.....	.....	.....	.....	.....	.....	**569**	**590**	**1,159**
Argentina	244	58	302	53	.....	53	.....	.....	.....	.....	.....	.....	297	58	355
Bolivia	17	85	102	44	20	64	.....	.....	.....	.....	.....	.....	61	105	166
Brazil	.....	187	187	71	59	130	.....	.....	.....	.....	.....	.....	71	246	317
British Guiana	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Chile	24	24	48	12	.....	12	.....	.....	.....	.....	.....	.....	36	24	60
Colombia	35	64	99	8	.....	8	.....	.....	.....	.....	.....	.....	43	64	107
Paraguay	.....	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	1	1
Peru	.....	26	26	24	.....	24	.....	.....	.....	.....	.....	.....	24	26	50
Venezuela	25	48	73	12	17	29	.....	.....	.....	.....	.....	.....	37	65	102
Central America & West Indies	.....	**53**	**53**	.....	**2**	**2**	.....	.....	.....	.....	.....	.....	.....	**55**	**55**
British Honduras	.....	12	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	12
Cuba	.....	6	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	6
Costa Rica	.....	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	2
Guatemala	.....	27	27	.....	2	2	.....	.....	.....	.....	.....	.....	.....	29	29
Trinidad	.....	6	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	6
Mexico	**96**	**108**	**204**	**24**	**36**	**60**	.....	.....	.....	.....	.....	.....	**120**	**144**	**264**
Canada	**312**	**484**	**796**	**2**	**39**	**41**	.....	**1**	**1**	.....	**3**	**3**	**314**	**527**	**841**
Alberta	226	323	549	.....	5	5	.....	.....	.....	.....	.....	.....	226	328	554
Saskatchewan	54	34	88	.....	1	1	.....	.....	.....	.....	.....	.....	54	35	89
British Columbia	25	96	121	.....	3	3	.....	.....	.....	.....	.....	.....	25	99	124
N. W. Territories	1	29	30	2	5	7	.....	.....	.....	.....	.....	.....	3	34	37
Nova Scotia	.....	2	2	.....	6	6	.....	1	1	.....	.....	.....	.....	9	9
Manitoba	6	.....	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	.....	6
New Brunswick	.....	.....	.....	.....	4	4	.....	.....	.....	.....	.....	.....	.....	4	4
Ontario	.....	.....	.....	.....	15	15	.....	.....	.....	.....	3	3	.....	18	18
United States	**2,289**	**2,808**	**5,097**	**243**	**305**	**548**	**35**	**16**	**51**	.....	.....	.....	**2,567**	**3,129**	**5,696**
Texas	692	1,019	1,711	67	82	149	12	16	28	.....	.....	.....	771	1,117	1,888
Louisiana	379	550	929	35	33	68	.....	.....	.....	.....	.....	.....	414	583	997
New Mexico	183	140	323	42	34	76	12	.....	12	.....	.....	.....	237	174	411
California	19	97	116	.....	20	20	.....	.....	.....	.....	.....	.....	19	117	136
Wyoming	173	127	300	1	21	22	.....	.....	.....	.....	.....	.....	174	148	322
Colorado	90	36	126	3	14	17	.....	.....	.....	.....	.....	.....	93	50	143
Montana	75	82	157	6	3	9	.....	.....	.....	.....	.....	.....	81	85	166
Florida	42	.....	42	3	.....	3	.....	.....	.....	.....	.....	.....	45	.....	45
Utah	74	70	144	.....	18	18	.....	.....	.....	.....	.....	.....	74	88	162
Oklahoma	144	164	308	.....	.....	.....	.....	.....	.....	.....	.....	.....	144	164	308
North Dakota	52	38	90	.....	5	5	.....	.....	.....	.....	.....	.....	52	43	95
Mississippi	234	203	437	33	21	54	.....	.....	.....	.....	.....	.....	267	224	491
Arkansas	38	26	64	.....	.....	.....	.....	.....	.....	.....	.....	.....	38	26	64
Kansas	62	59	121	12	.....	12	11	.....	11	.....	.....	.....	85	59	144
Arizona	2	24	26	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	24	26
Alaska	15	82	97	3	7	10	.....	.....	.....	.....	.....	.....	18	89	107
Alabama	6	21	27	15	5	20	.....	.....	.....	.....	.....	.....	21	26	47
Other	9	70	79	23	42	65	.....	.....	.....	.....	.....	.....	32	112	144
Eastern Hemisphere	**564**	**2,171**	**2,735**	**66**	**451**	**517**	**1**	**108**	**109**	.....	**105**	**105**	**631**	**2,835**	**3,466**
Europe, Total	**278**	**748**	**1,026**	**24**	**64**	**88**	**1**	**11**	**12**	.....	**99**	**99**	**303**	**922**	**1,225**
Austria	37	34	71	12	.....	12	.....	.....	.....	.....	33	33	49	67	116
France	12	170	182	.....	16	16	.....	9	9	.....	.....	.....	12	195	207
Germany	106	350	456	.....	27	27	.....	.....	.....	.....	29	29	106	406	512
Italy & Sicily	79	116	195	12	8	20	1	2	3	.....	37	37	92	163	255
Netherlands	12	15	27	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	15	27
Spain	15	36	51	.....	13	13	.....	.....	.....	.....	.....	.....	15	49	64
Switzerland	5	12	17	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	12	17
United Kingdom	12	15	27	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	15	27
Africa, Total	**190**	**829**	**1,019**	**21**	**95**	**116**	.....	**17**	**17**	.....	.....	.....	**211**	**941**	**1,152**
Algeria Tunisia and Morocco	22	342	364	9	.....	9	.....	.....	.....	.....	.....	.....	31	342	373
Cabinda	.....	12	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	12
Egypt	12	13	25	.....	12	12	.....	.....	.....	.....	.....	.....	12	25	37
Fr. E. & W. Africa	12	6	18	.....	1	1	.....	.....	.....	.....	.....	.....	12	7	19
Gabon	12	21	33	.....	7	7	.....	.....	.....	.....	.....	.....	12	28	40
Libya	48	264	312	12	20	32	.....	6	6	.....	.....	.....	60	290	350
Ivory Coast	.....	8	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	8
Madagascar	.....	6	6	.....	5	5	.....	.....	.....	.....	.....	.....	.....	11	11
Nigeria	24	74	98	.....	.....	.....	.....	.....	.....	.....	.....	.....	24	74	98
Portugese Guinea	.....	13	13	.....	24	24	.....	.....	.....	.....	.....	.....	.....	37	37
Senegal	12	32	44	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	32	44
Br. Somaliland	.....	9	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	9
It. Somaliland	.....	4	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	4
Mozambique	24	.....	24	.....	22	22	.....	11	11	.....	.....	.....	24	33	57
Other	24	25	49	.....	4	4	.....	.....	.....	.....	.....	.....	24	29	53
Middle East	**46**	**309**	**355**	**9**	**106**	**115**	.....	**20**	**20**	.....	**2**	**2**	**55**	**437**	**492**
Aden	.....	3	3	.....	12	12	.....	.....	.....	.....	.....	.....	.....	15	15
Dhofar	.....	24	24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	24	24
Israel	.....	12	12	.....	2	2	.....	.....	.....	.....	2	2	.....	16	16
Iran	10	45	55	9	42	51	.....	.....	.....	.....	.....	.....	19	87	106
Iraq	12	63	75	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	63	75
Saudi Arabia	.....	31	31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	31	31
Turkey (Asian)	24	57	81	.....	16	16	.....	8	8	.....	.....	.....	24	81	105
Syria	.....	20	20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20	20
Qatar	.....	7	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7	7
Oman	.....	39	39	.....	34	34	.....	12	12	.....	.....	.....	.....	85	85
Lebanon	.....	7	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7	7
Other	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Far East, Total	**50**	**285**	**335**	**12**	**186**	**198**	.....	**60**	**60**	.....	**4**	**4**	**62**	**535**	**597**
Burma	.....	12	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	12
India	.....	46	46	.....	58	58	.....	58	58	.....	.....	.....	.....	162	162
Indonesia	3	42	45	.....	12	12	.....	.....	.....	.....	.....	.....	3	54	57
Japan	11	58	69	9	25	34	.....	.....	.....	.....	4	4	20	87	107
New Guinea	.....	11	11	.....	7	7	.....	.....	.....	.....	.....	.....	.....	18	18
Pakistan	16	50	66	.....	26	26	.....	2	2	.....	.....	.....	16	78	94
Philippines	.....	23	23	.....	55	55	.....	.....	.....	.....	.....	.....	.....	78	78
Australia	.....	23	23	.....	3	3	.....	.....	.....	.....	.....	.....	.....	26	26
Formosa	20	.....	20	3	.....	3	.....	.....	.....	.....	.....	.....	23	.....	23
New Zeland	.....	12	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	12
Other	.....	8	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	8

North America . . .

U. S., Canada, and Mexico boost production as petroleum use increases



MEXICO IS IN THE SPOTLIGHT of petroleum development in North America, showing vigorous expansion. But steady gains in oil and gas use and production are continuing also in Canada and the United States.

Mexico this year added 50 percent more drilling rigs and expects to complete about 50 percent more new wells than in 1959. Petroleum demand is increasing sharply and supply is being expanded to meet it.

Nearly a dozen new oil and gas fields were discovered in Mexico in 1959, mainly in the Isthmus and the Tampico regions.

Canada produced both oil and gas at record rates in 1959, and will further expand output in 1960, although somewhat fewer wells may be drilled.

Development of natural gas will be emphasized in Canada. Demand for gas is good, while the markets are absorbing only about one half of the country's oil producing ability.

The United States has had a slowing down of the usual growth of demand for oil during the past three years and has had difficulty holding supply within needs. But drilling and production have been curtailed, and surpluses have been brought under better control. Stronger markets and better prices consequently are promised for the remainder of this year.

U.S. demand and supply . . .

More crude oil needed in 1960 to meet 3.5% rise in demand

THE OIL INDUSTRY of the United States currently has an improved outlook, with hopes of better markets, prices and earnings in the latter half of 1960. The improvement stems from better balancing of supply with demand since the beginning of this year.

Previously, there were periods of overproduction of crude oil and natural gas liquids, and excessive imports of crude and products. Supply exceeded lagging demand. Prices of products sank to low and sometimes unprofitable levels. Crude oil prices have been gradually working lower since 1957.

The industry since 1957 has been troubled from both the demand and supply sides. Demand was adversely affected during the recession of 1958, improved in 1959, but again lagged somewhat in 1960. Relatively warm weather during the past December, January and February made the latest heating oil season generally lean for profits. Meanwhile, actual and potential supply have been so large as to keep markets disturbed and prices low.

Demand. Total demand for all oils in 1960 will average 9,998,000 barrels daily, an increase of 336,000 barrels or 3.5 percent over 1959. This is the recently revised forecast of the U. S. Bureau of Mines. It is somewhat short of the bureau's expectations at the beginning of the year.

Lagging of demand has been under way since 1957. In 1958, the total demand was down 3/10 of 1 percent. In 1959, it was up 3.2 percent. These results contrast with typical increases

Supply and Demand for All Oils in the United States, by Quarters, Showing the Year 1959 and a Revised Forecast of 1960

(Thousand Barrels Daily . . . Source: U. S. Bureau of Mines)

	1st QUARTER			2nd QUARTER			3rd QUARTER			4th QUARTER			YEAR		
	1959	1960	%Up	1959	1960[1]	% Up	1959	1960[2]	% Up	1959	1960[2]	% Up	1959	1960[2]	% Up
SUPPLY															
Production	**8,081**	**8,153**	**0.9**	**8,052**	**7,825**	**—2.8**	**7,658**	**8,070**	**5.4**	**7,945**	**8,265**	**4.0**	**7,933**	**8,079**	**1.8**
Crude Oil	7,202	7,199	...	7,187	6,925	—3.6	6,802	7,180	5.6	7,029	7,325	4.2	7,054	7,158	1.5
Other Oils	879	954	8.5	865	900	4.0	856	890	4.0	916	940	2.6	879	921	4.8
Imports	**2,224**	**1,953**	**—12.2**	**1,598**	**1,681**	**5.2**	**1,534**	**1,583**	**3.2**	**1,777**	**1,900**	**6.9**	**1,780**	**1,779**	**—0.1**
Crude Oil	958	990	3.3	962	1,020	6.0	945	960	1.6	996	995	—0.1	965	984	2.0
Products	1,266	963	—23.9	636	661	3.9	589	623	5.8	781	905	15.9	815	795	—2.5
New Supply	10,305	10,106	— 1.9	9,650	9,506	—1.5	9,192	9,653	5.0	9,722	10,165	4.6	9,713	9,858	1.5
Stock Change	**—338**	**—695**	...	**+631**	**+193**	...	**+175**	**+263**	...	**—267**	**—325**	...	**+51**	**—140**	...
Crude Oil	—87	+42	...	+193	—41	...	—234	—2	...	+67	—14	...	—15	—4	...
Other Oils[4]	—251	—737	...	+438	+234	...	+409	+265	...	—334	—311	...	+66	—136	...
DEMAND															
Total Demand	**10,643**	**10,801**	**1.5**	**9,019**	**9,313**	**3.3**	**9,017**	**9,390**	**4.1**	**9,989**	**10,490**	**5.0**	**9,662**	**9,998**	**3.5**
Gasoline	3,759	3,778	0.5	4,305	4,445	3.3	4,407	4,500	2.1	3,972	4,180	5.2	4,111	4,226	2.8
Kerosine[3]	466	493	5.8	162	202	24.7	201	242	20.4	390	433	11.0	304	325	6.9
Distillate	2,670	2,738	2.5	1,372	1,405	2.4	1,216	1,260	3.6	2,129	2,260	6.2	1,843	1,915	3.9
Residual	2,088	2,014	— 3.5	1,433	1,452	1.3	1,241	1,361	9.7	1,656	1,720	3.9	1,603	1,637	2.1
All Others[3]	1,660	1,778	7.1	1,747	1,809	3.5	1,952	2,027	3.8	1,842	1,897	3.0	1,801	1,895	5.2
Exports	**224**	**202**	**— 9.8**	**225**	**209**	**—7.1**	**201**	**200**	**—0.5**	**193**	**200**	**3.6**	**211**	**202**	**—4.3**
Crude Oil	7	9	28.6	7	7	...	6	7	16.7	7	7	...	7	7	...
Products	217	193	—11.1	218	202	—7.3	195	193	—1.0	186	193	3.8	204	195	—4.4
Domestic Demand	**10,419**	**10,599**	**1.7**	**8,794**	**9,104**	**3.5**	**8,816**	**9,190**	**4.2**	**9,796**	**10,290**	**5.0**	**9,451**	**9,796**	**3.7**
Gasoline	3,719	3,744	0.7	4,251	4,400	3.5	4,363	4,450	2.0	3,929	4,135	5.2	4,066	4,183	2.9
Kerosine[3]	464	490	5.6	161	200	24.2	198	240	21.2	385	430	11.7	301	340	13.0
Distillate	2,632	2,708	2.9	1,338	1,370	2.4	1,179	1,225	3.9	2,100	2,220	5.7	1,809	1,880	3.9
Residual	2,009	1,957	— 2.6	1,371	1,397	1.9	1,195	1,315	10.0	1,615	1,675	3.7	1,547	1,586	2.5
All Others[3]	1,595	1,700	6.6	1,673	1,737	3.8	1,881	1,960	4.2	1,767	1,830	3.6	1,728	1,807	4.6
Runs to Stills	8,190	8,088	— 1.2	7,916	7,952	0.5	7,947	8,105	2.0	7,924	8,300	4.7	7,994	8,112	1.5

[1] Partial estimate. [2] Estimated. [3] Beginning in 1960, commercial jet fuel, formerly included in the "All Other" group, is now included with kerosine. [4] Refined products and natural gas liquids.

around 5 percent in eariler postwar years. And it has been difficult for the industry to adjust to the slower rates of growth of business volumes.

However, it may be that the industry will have to be content with slower growth henceforth. Working against faster growth are various factors, including increased competition from natural gas, slower sales of new motor vehicles, traffic congestion and wide use of small automobiles.

Expected increases in demand in 1960 include gains of 2.8 percent for gasoline, 6.9 percent for kerosine, 3.9 percent for distillate fuel oil, 2.1 percent for residual fuel oil and 5.2 percent for all other oils combined.

Supply. After adding unnecessarily to product stocks in 1959, the U. S. industry is expected to make some essential net withdrawals of products from storage in 1960. Assuming such withdrawals, the Bureau of Mines figured a need for new supply of 9,858,000 barrels daily in 1960, up only 145,000 barrels or 1.5 percent.

Total imports are expected to be about the same in 1960 as in 1959. And production of natural gas liquids is forecast at 921,000 barrels daily, up 42,000 barrels or 4.8 percent. This would leave a need for 7,158,000 barrels per day of crude oil production, up 104,000 barrels or 1.5 percent.

U. S. Crude Oil Production, by States and Districts, in First Half of Year, 1960 and 1959

From U. S. Bureau of Mines, except May and June, 1960, from API weekly reports, and breakdown of Texas by districts from API.

STATE or DISTRICT	Thousands of Barrels		Thous. Bbls. Daily		% Diff. 1960-1959
	1960	1959	1960	1959	
Alabama	**3,167**	**2,396**	**17.4**	**13.2**	**+ 31.8**
Arkansas	**14,149**	**14,264**	**77.8**	**78.8**	**— 1.3**
California	**151,502**	**152,840**	**832.4**	**844.4**	**— 1.4**
Colorado	**23,334**	**22,838**	**128.2**	**126.2**	**+ 1.6**
Florida	**197**	**213**	**1.1**	**1.2**	**— 8.3**
Illinois	**38,881**	**38,914**	**213.6**	**215.0**	**— 0.7**
Indiana	**5,814**	**6,044**	**32.0**	**33.4**	**— 4.2**
Kansas	**55,173**	**60,218**	**303.2**	**332.7**	**— 8.9**
Kentucky	**11,092**	**13,488**	**60.9**	**74.5**	**— 18.3**
Louisiana	**194,609**	**171,261**	**1,069.3**	**946.2**	**+ 13.0**
North Louisiana	21,836	22,012	120.0	121.6	— 1.3
South Louisiana	172,773	149,249	949.3	824.6	+ 15.1
Michigan	**6,716**	**4,812**	**36.9**	**26.6**	**+ 38.7**
Mississippi	**25,569**	**22,415**	**140.5**	**123.9**	**+ 13.4**
Montana	**14,730**	**14,768**	**80.9**	**81.6**	**— 0.9**
Nebraska	**11,480**	**11,094**	**63.1**	**61.3**	**+ 2.9**
New Mexico	**54,447**	**51,946**	**299.2**	**287.0**	**+ 4.3**
Southeast N. Mex.	46,487	45,032	255.5	248.8	+ 2.7
Northwest N. Mex.	7,960	6,914	43.7	38.2	+ 14.4
New York	**915**	**978**	**5.0**	**5.4**	**— 7.4**
North Dakota	**10,317**	**8,887**	**56.7**	**49.1**	**+ 15.5**
Ohio	**2,370**	**2,796**	**13.0**	**15.4**	**— 15.6**
Oklahoma	**97,245**	**100,718**	**534.3**	**556.4**	**— 4.0**
Pennsylvania	**3,066**	**2,979**	**16.8**	**16.5**	**+ 1.8**
Texas*	**473,657**	**515,694**	**2,602.5**	**2,849.1**	**— 8.7**
Dist. 1: S. Central	8,035	8,310	44.1	45.9	— 3.9
Dist. 2: Middle Gulf	21,363	22,663	117.4	125.2	— 6.2
Dist. 3: Upper Gulf	65,956	73,221	362.4	404.5	— 10.4
Dist. 4: L. Gulf-S.W.	34,743	36,532	190.9	201.8	— 5.4
Dist. 5: E. Central	5,018	5,693	27.6	31.5	— 12.4
Dist. 6: Northeast	45,752	51,078	251.4	282.2	— 10.9
Dist. 7-B: N. Central	23,708	25,599	130.3	141.4	— 7.9
Dist. 7-C: W. Central	22,757	24,688	125.0	136.4	— 8.4
Dist. 8: West Texas	188,822	202,790	1,037.5	1,120.4	— 7.4
Dist. 9: North Texas	35,509	37,743	195.1	208.5	— 6.4
Dist. 10: Panhandle	19,778	19,407	108.7	107.2	+ 1.4
Utah	**19,423**	**19,990**	**106.7**	**110.4**	**— 3.4**
West Virginia	**1,118**	**1,067**	**6.1**	**5.9**	**+ 3.4**
Wyoming	**62,299**	**61,449**	**342.3**	**339.5**	**+ 0.8**
Others†	**291**	**111**	**1.6**	**0.6**	**+166.7**
Total, U. S.	**1,281,561**	**1,302,180**	**7,041.5**	**7,194.3**	**— 2.1**

* Data for Texas by districts are from API and do not agree with Texas total, which is from Bureau of Mines, except May and June 1960, from API.
† Includes Alaska, Missouri, Nevada, South Dakota, Tennessee, and Washington.

Table 1—Summary of U.S. Drilling and Wildcatting Forecasts, 1960 vs. 1959

PERIOD	Total New Wells	Producing Wells	Wildcats	Total Footage
Year:				
1960	46,324	27,072	9,191	193,996,893
1959	49,331	29,555	9,907	205,698,272
% Change	—6.1	—8.4	—7.2	—5.7
Latter Half:				
1960	23,721	13,788	4,759	98,875,290
1959	25,308	14,649	5,335	106,163,536
% Change	—6.3	—6.2	—10.8	—6.9
First Half:				
1960	22,603	13,284	4,432	95,121,604
1959	24,023	14,861	4,552	99,534,736
% Change	—5.9	—10.6	—2.6	—4.4

U.S. drilling forecast . . . upturn in activity is indicated for latter half of 1960

INCREASED DRILLING activity in the United States is forecast for the second half of 1960 as compared with the first six months. However, this rise will not be sufficiently large to restore the annual level of drilling operations to the 1959 level by about 3,000 wells.

WORLD OIL forecasts the drilling of 23,721 wells and 98,875,290 feet of hole in the United States during the last half of 1960. This prediction is based on a midyear survey of oil company drilling plans.

Second half gains. This second-half drilling rate would amount to an increase of 1,118 wells, or 4.9 percent, over the 22,603 wells completed during the first six months of 1960. Paralleling the predicted drilling rate improvement, footage forecast for the last six months of 1960 would represent an increase of 3,753,687 feet, or 3.9 percent, compared with the first half of the year. This amount would be almost 7 percent less than the 106,163,536 feet of hole drilled during the last six months of 1959.

This drilling rate during the last half of 1960 would result in a total of 46,324 wells being drilled in the United States during the complete year. This is equal to a drop of 3,007 wells from 1959.

Footage for the entire year of 1960, it is forecast, will reach a level of 193,996,893 feet, or 11,701,379 feet less than the footage drilled during the previous year.

U.S. outlook is improved. As indicated by the anticipated 4.9 percent increase in drilling activity in the last six months of 1960, U.S. oil producers will be in a more favorable economic condition in the second half than during the first half of the year. According to the Bureau of Mines' revised outlook, a gain in domestic demand for all oils of 4.7 percent is forecast for the second half of 1960 while the increase in domestic demand for the first half of the year compared with 1959 was expected to be approximately 2.6 percent.

In adition, the Bureau's estimate of domestic demand for all oils this year is 9,796,000 barrels a day, up 3.7 percent from 1959. This Bureau forecast incorporates actual first quarter figures and API data for April and May.

Rise in producing wells. Based on industry trends and reports, as well as

Table 2—Forecast of U.S. Wildcats to Be Drilled in Last Six Months, 1960, and in Year 1960

STATE or DISTRICT	1960 Latter Half	1960 First Half	1960 Year	1959 Year Total	% Diff. 1960-1959
Alabama	3	3	6	30	—80.0
Alaska	4	4	8	9	—11.1
Arizona	25	12	37	35	+ 5.7
Arkansas	84	62	146	129	+13.2
California	150	143	293	327	—10.4
Colorado	222	149	371	390	— 4.9
Illinois	322	312	634	499	+27.1
Indiana	157	162	319	251	+27.1
Kansas	478	430	908	1,188	—23.6
Kentucky	32	29	61	89	—31.5
Louisiana	312	256	568	537	+ 5.8
North Louisiana	154	103	257	212	+21.2
South Louisiana	158	153	311	325	— 4.3
* Gulf of Mexico	16	19	35	36	— 2.8
Michigan	135	104	239	167	+43.1
Mississippi	125	121	246	252	— 2.4
Montana	82	56	138	110	+25.5
Nebraska	198	187	385	377	+ 2.1
New Mexico	194	194	388	279	+39.1
Southeast	125	138	263	189	+39.2
Northwest	69	56	125	90	+38.9
North Dakota	27	31	58	83	—30.1
Ohio	30	23	53	41	+29.3
Oklahoma	219	248	467	729	—35.9
Pennsylvania	7	9	16	24	—33.3
South Dakota	10	5	15	14	+ 7.1
Tennessee	42	23	65	57	+14.0
Texas	1,669	1,650	3,319	3,825	—13.2
Dist. 1: South Central	153	149	302	308	— 2.0
Dist. 2: Middle Gulf	110	120	230	283	—18.7
Dist. 3: Upper Gulf	131	139	270	287	— 5.9
Dist. 4: Lower Gulf-S.W.	232	187	419	410	+ 2.2
Dist. 5 & 6: East	170	145	315	259	+21.6
Dist. 7-B & 9: North	550	553	1,103	1,333	—17.3
Dist. 7-C & 8: West	268	306	574	789	—27.3
Dist. 10: Panhandle	55	51	106	156	—32.1
Utah	35	44	79	84	— 6.0
Wyoming	182	165	347	350	— 0.9
Other States[1]	15	10	25	31	—19.4
Total United States	4,759	4,432	9,191	9,907	— 7.2

* Gulf of Mexico wells are included in South Louisiana figures.

[1] Other states include Florida, Georgia, Idaho, Maryland, Nevada, North Carolina, Oregon, Virginia and Washington.

on a predicted upturn in drilling activity during the last half of 1960, WORLD OIL forecasts the completion of 13,788 new oil, gas and distillate wells during the period. This reflects a gain over the first half of 504 completions. During the first six months, 13,284 new oil, gas and distillate wells were completed. That indicates the total for 1960 should reach 27,072 wells, or 2,483 fewer than the total for the preceding year.

Second half completions will include 11,257 new oil wells and 2,531 new gas and distillate wells. Based on this revised second half forecast, there should be approximately 22,162 new oil wells and 4,910 new gas and distillate wells completed in the United States this year.

Increase second-half wildcatting. Rising drilling rates in the United States during the second half of 1960 as compared with the first six months of the year will include an increase in the number of wildcat tests.

WORLD OIL forecasts the drilling of 4,759 wildcat tests during the second half as compared with 4,432 during the first half.

Although this expanded wildcatting rate will, for the entire year, be 7.2 percent below the 1959 level, it should account for the completion of 9,191 wildcat tests for the whole of 1960. In 1959, for comparison, 9,907 wildcats were drilled.

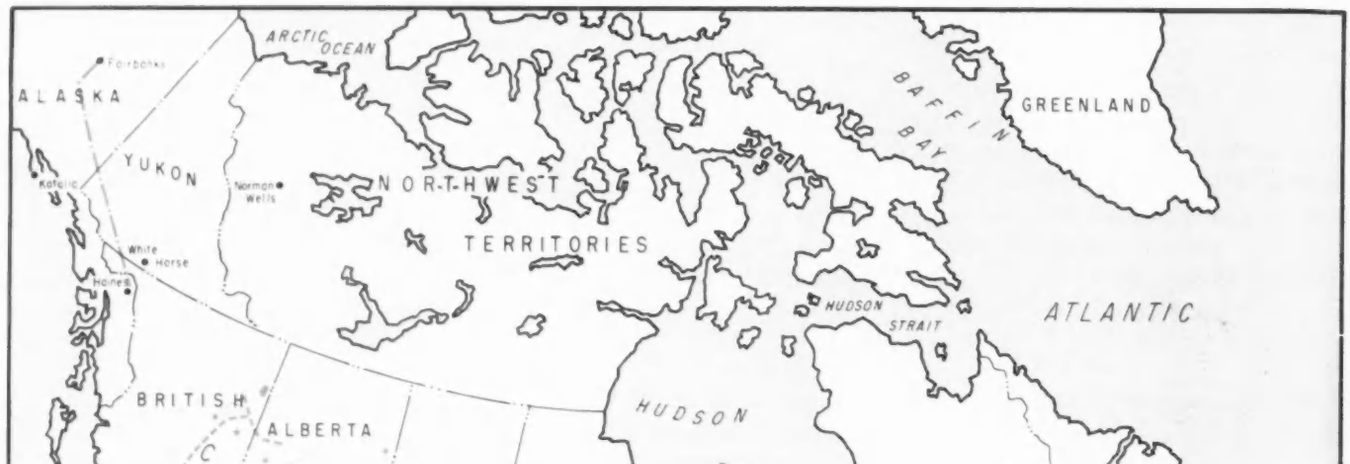
TABLE 3—Forecast of U.S. Wells and Footage To Be Drilled in Last Six Months, 1960, and in Year 1960

Forecast covers all new wells to be drilled for oil or gas in 1960, salt water disposal wells, and water or gas-input wells for repressuring and secondary recovery, but does not estimate old wells drilled deeper.

STATE or DISTRICT	NEW WELLS					FOOTAGE				
	1960			†1959 Year (Actual)	% Diff. 1960-1959	1960			†1959 Year (Actual)	% Diff. 1960-1959
	Latter Half	First Half (Actual)	Year			Latter Half	First Half (Actual)	Year		
Alabama	31	29	60	108	—44.5	305,350	285,964	591,314	976,926	— 39.5
Alaska	7	8	15	14	+ 7.1	83,600	95,571	179,171	141,670	+ 26.5
Arizona	27	13	40	36	+11.1	67,500	32,672	100,172	94,329	+ 6.2
Arkansas	404	296	700	814	—14.0	1,474,600	1,077,923	2,552,523	2,728,131	— 6.4
California	730	695	1,425	1,520	— 6.3	3,431,000	3,272,356	6,703,356	7,240,301	— 7.4
Colorado	449	301	750	726	+ 3.3	2,357,250	1,587,901	3,945,151	3,818,603	+ 3.3
Illinois	949	921	1,870	2,033	— 8.0	1,945,450	1,867,903	3,813,353	4,492,151	— 15.1
Indiana	445	455	900	869	+ 3.7	578,500	594,140	1,172,640	1,332,939	— 12.0
Kansas	2,765	2,485	5,250	4,778	+ 9.9	9,677,500	8,706,900	18,384,400	17,022,811	+ 8.0
Kentucky	1,606	1,419	3,025	2,930	+ 3.2	1,365,100	1,202,260	2,567,360	2,646,843	— 3.0
Louisiana	1,957	1,648	3,605	3,831	— 5.9	14,843,400	13,437,932	28,281,332	29,289,485	— 3.5
North Louisiana	839	561	1,400	1,543	— 9.3	3,272,100	2,187,987	5,460,087	5,445,656	+ 0.3
South Louisiana	1,118	1,087	2,205	2,288	— 3.6	11,571,300	11,249,945	22,821,245	23,843,829	— 4.3
Gulf of Mexico[1]	238	282	520	474	+ 9.7	2,427,600	2,870,824	5,298,424	4,867,623	+ 8.9
Michigan	463	357	820	596	+37.6	1,689,950	1,309,682	2,999,632	1,866,492	+ 60.7
Mississippi	368	357	725	669	+ 8.4	3,643,200	3,538,873	7,182,073	6,291,843	+ 14.1
Missouri	6	9	15	14	+ 7.1	15,900	23,973	39,873	12,901	+209.1
Montana	199	136	335	342	— 2.1	985,050	674,163	1,659,213	1,639,710	+ 1.2
Nebraska	476	449	925	825	+12.1	2,737,000	2,573,489	5,310,489	4,872,812	+ 9.0
New Mexico	918	907	1,825	1,819	+ 0.3	4,357,300	4,353,845	8,711,145	7,580,624	+ 14.9
Southeast	560	615	1,175	1,015	+15.8	2,800,000	3,090,237	5,890,237	4,691,142	+ 25.6
Northwest	358	292	650	804	—19.2	1,557,300	1,263,608	2,820,908	2,889,482	— 2.4
New York	140	140	280	278	+ 0.7	238,000	241,365	479,365	481,275	— 0.4
North Dakota	129	146	275	433	—36.5	806,250	910,952	1,717,202	2,741,670	— 37.4
Ohio	620	480	1,100	1,085	+ 1.4	1,519,000	1,164,567	2,683,567	2,761,713	— 2.8
Oklahoma	1,995	2,255	4,250	5,192	—18.2	7,880,250	8,945,900	16,826,150	19,137,906	— 12.1
Pennsylvania	333	407	740	695	+ 6.5	999,000	1,215,123	2,214,123	2,148,815	+ 3.0
South Dakota	30	15	45	23	+95.7	219,000	109,724	328,724	168,360	+ 95.3
Tennessee	71	39	110	107	+ 2.8	56,800	31,026	87,826	100,422	— 12.6
Texas	7 584	7,641	15,225	17,597	—13.5	33,376,200	33,774,117	67,150,317	77,636,405	— 13.5
Dist. 1: South Central	501	489	990	979	+ 1.1	1,427,850	1,402,762	2,830,612	2,587,789	+ 9.4
Dist. 2: Middle Gulf	359	391	750	786	— 4.6	2,387,350	2,608,771	4,996,121	4,910,719	+ 1.7
Dist. 3: Upper Gulf	533	567	1,100	1,190	— 7.6	3,784,300	4,036,539	7,820,839	8,439,430	— 7.3
Dist. 4: L. Gulf-S.W.	651	524	1,175	1,308	—10.2	3,678,150	2,951,738	6,629,888	7,115,371	— 6.8
Dist. 5 & 6: East	600	510	1,110	1,002	+10.8	3,210,000	2,722,927	5,932,927	5,502,923	+ 7.8
Dist. 7-B & 9: North	2,593	2,607	5,200	5,889	—11.7	7,260,400	7,276,842	14,537,242	17,372,645	— 16.3
Dist. 7-C & 8: West	1,726	1,974	3,700	5,194	—28.8	8,802,600	10,128,602	18,931,202	26,017,305	— 27.2
Dist. 10: Panhandle	621	579	1,200	1,249	— 3.9	2,825,550	2,645,936	5,471,486	5,690,223	— 3.9
Utah	89	111	200	291	—31.3	489,500	614,415	1,103,915	1,623,988	— 32.0
West Virginia	416	419	835	783	+ 6.6	1,102,400	1,108,014	2,210,414	2,009,755	+ 10.0
Wyoming	498	452	950	898	+ 5.8	2,539,800	2,296,553	4,836,353	4,687,227	+ 3.2
Other States*	16	13	29	25	+16.0	91,440	74,300	165,740	152,165	+ 8.9
Total United States	23,721	22,603	46,324	49,331	— 6.1	98,875,290	95,121,603	193,996,893	205,698,272	— 5.7

[1] Gulf of Mexico wells are included in South Louisiana figures.
*Other states include Florida, Georgia, Idaho, Maryland, Nevada, North Carolina, Oregon, Virginia, and Washington.
†Revised totals.

OIL AND GAS FIELDS, PIPE LINES, AND REFINERIES OF CANADA



Canada . . . natural gas to take spotlight in 1960-1961. Oil production rises. Drilling is reduced

CANADA IS SWITCHING its exploration emphasis from oil to gas.

Vast potential oil areas remain to be tested. However, Canada's crude production rate currently is running only about 50 percent of potential. Result: Trade Minister Gordon Churchill has announced that an examination of Canada's crude oil marketing will be a "priority task" for him shortly.

Behind this announcement is the 700,000 barrels per day crude production target the Borden Commission established as an alternate to replacing overseas crude at the Montreal refineries with Western Canada crude. Although few believe the 700,000 barrels per day figure will be reached in 1960, it is predicted in some circles that production may approach 600,000 barrels per day by year's end.

In the meantime, more and more rigs are being pushed into exploration and development of natural gas. Exports of natural gas liquids into the U.S., finally approved by the Canadian Government after many years of delay, now await approval of the U.S. Federal Power Commission.

1959 in review. Although Canada's oil wells were producing far below their potential, average daily output increased 11.6 percent in 1959 to 506,213 barrels per day from 453,435 in 1958.

Total well completions dropped 100 in 1959, to 2,856 from 2,956. Footage drilled was down 484,091 to 13,208,460 feet.

Of the wells completed last year, 1,470 were oil, 395 gas, and 991 dry, for a 34.7 percent success ratio.

Canada's crude oil reserves were increased 331 million barrels during the year, to 3.5 billion barrels. Natural gas reserves totaled 26.6 trillion cubic feet at the end of 1959, up 3.3 trillion cubic feet from one year previously.

Western Canada. The industry cleared many hurdles in 1959 and emerged with record rates of both oil and natural gas production. In the 13-year period which started with the Leduc discovery in 1947, Western Canada's crude production increased from 19,000 to 506,210 barrels daily in 1959. During the same period, natural gas output rose from 181 million to 1,306 million cubic feet daily.

Even though production of liquid hydrocarbons was 3 percent higher last year, lower prices dropped revenue to $450 million or 1 percent

lower than the record $454 million in 1957.

Drilling activity, with 2,516 well completions during the year, was slightly higher than during 1958 and the 12.6 million feet of hole exceeded the previous year's mark by more than 200,000 feet.

Outlook for 1960. While drilling activity in Western Canada declined somewhat during the first half of 1960, an early clarification of the natural gas situation could push completions for the year to near the 1959 level. Even with the lower rate in total completions, and with a switch in activity from Saskatchewan and Manitoba to the deeper sediments in British Columbia and the Northwest Territories, footage drilled is on the increase. It is expected that completions in 1960 will total about 2,258 wells, with total footage approaching 12.4 million feet.

The Canadian Government early in 1960 approved the request of three companies to export 850 million of cubic feet daily of natural gas to the U.S. The U.S. Federal Power Commission has approved the import of a quarter of that, but a favorable decision on the balance would spark one of the greatest growths any Canadian industry has ever undergone. It is expected that by 1962 at least 400 billion cubic feet yearly with a border value exceeding $100 million will be moved into United States markets through seven export pipe lines. This would be in sharp contrast with 1959 border sales of 85 billion cubic feet representing a value of about $17,000,000. By 1970, annual export is expected to reach 1,000 billion cubic feet, with U.S. dollar earnings amounting to some $300 million yearly.

First effect of the gas decisions will be a 20-month, $500 million capital investment in Western Canada. Of this, about $300 million will be spent in transmission pipelines in Alberta, British Columbia and Manitoba. About $150 million will be spent in Alberta in gas utilization projects such as plants and gathering lines, and $50 million in the drilling of gas exploration development wells.

While the Western Canada gas picture seems bright for the future, the crude oil situation is not so clear. Although Western Canada's potential currently is about 1.1 million barrels

View of Texas Gulf Sulphur's Wildhorse Creek Mississippian zone gas discovery well in the Foothills area of Alberta.

Highlights of Major Developments in Western Canada During 1959-60

- Western Canada exploration and oil industry economy appear to be switching rapidly from oil to natural gas.
- Drilling activity is shifting from southeastern prairie areas, principally Saskatchewan and Manitoba, to the north country.
- Even with slackening of drilling in Saskatchewan and Manitoba, footage for Western Canada during 1960 is showing an increase due to the deeper sediments in British Columbia and N.W.T. areas.
- If U.S. Federal Power Commission approves the gas export projects proposed by three companies, and which already have been approved by Canada, it could spark one of the greatest expansions in gas development ever experienced.
- Extensions and further drilling in the prolific Kotcho Lake and Petitot River areas in northern British Columbia, 1958 discoveries, reveal tremendous new gas reserves rivaling some of Alberta's largest discoveries.
- Exploration drilling in that northern B.C. region to date has maintained the remarkable ratio of one successful well for every two wildcats drilled.

per day, and actual production averages nearly 550,000 barrels daily, the country still imports from the Near and Middle East and Venezuela almost one-half of its refinery requirements of nearly 825,000 barrels per day.

Late in 1959 the Borden Royal Commission, which probed into Canada's oil and gas industry, recommended that the industry, by the end of 1960, find a market for 700,000 barrels of domestic production. It is apparent that this goal will not be reached and, consequently, it is felt that some form of Government intervention will be induced—either by import quotas and/or by change in the tariff set-up.

Rigs shift to north country. Saskatchewan and Manitoba have experienced a serious slackening in activity. Both areas, showing favorable rates of exploration and development during the past few years, have at least temporarily "run out of zone."

Both regions have experienced heavy development in the Mississippian, but with exploration failing to find additional significant reserves either in that or deeper zones, interest has faded accordingly.

The first half of 1960 has seen 215 well completions (oil, gas, dry) in Saskatchewan, compared with 436 during the same period last year. Only 25 had been reported in Manitoba through June of this year. Of the Saskatchewan wells, only six have been new pool discoveries.

On the other hand, interest in British Columbia and the Northwest Territories has been increasing rapidly during the past 18 months due to some very significant strikes. In both areas, rig activity early this year was at a record high, with 45 working in British Columbia and as many as 13 in N.W.T.

Although Alberta operations have failed to uncover any major strikes since 1959, the discovery rate has remained fairly constant and should increase slightly this year since exploration activity is increasing.

Geophysical activity down. The outlook for geophysical activity in Western Canada is far from bright.

November 1959 saw the lowest rate of activity since 1947, when 43 seismograph crews were operating and the upward trend was just starting. While active crews increased to 102 in mid-February of this year, activity dropped to as low as 26 active crews during the first half of 1960.

Interest in Arctic Islands. Weeding out of unpromising areas has resulted in a reduction of Arctic Island land permits from an original 130 million acres to the current 40 million.

Although the area is remote, many firms are carrying out preliminary work and one company has announced it will drill a well in the not-too-distant future.

MAJOR YUKON-N.W.T. STRIKES

An oil discovery in the Yukon-Northwest Territories in 1959, and a natural gas find early this year in the southern portion of that expanse, completely overshadowed any other Western Canadian strikes.

Those discoveries, although not involving production potentials as high as some in British Columbia or even run-of-the-mill strikes in Alberta, were of unusual significance by being the first commercial finds since the Norman Wells field was discovered in 1920.

The oil discovery, Western Minerals et al Chance 1, in the Eagle Plains area, is 320 miles west-northeast of Norman Wells, 200 miles south of the MacKenzie River delta and 450 miles east-northeast of the Pacific Ocean.

Located 50 miles south of the closest previous test, a 9,589-foot abandonment, the well found production in a 135-foot zone in the Permo-Pennsylvanian limestone at 4,250 feet. Two separate drillstem tests in the horizon flowed condensate bearing natural gas at rates up to 8 million cubic feet daily and a third evaluation flowed light gravity crude oil. Another productive zone reportedly was found at 5,190 feet.

The well was suspended for a time following discovery due to a shortage of supplies but is once again drilling ahead. In July 1960 it was drilling below 8,600 feet.

The natural gas find was in the Celibeta Lake region, 35 miles northwest of British Columbia's Petitot River gas field, and eight miles north of the British Columbia boundary. Like the Petitot River field, the new discovery found its production in the Slave Point member of the Middle Devonian. Flow was from the interval 3,738 to 3,758 feet.

Drilled by the team of Home Oil Company Limited, Signal Oil and Gas Company, Kern County Land Company, Alminex Limited and United Oils Limited on the largest tract of untested farmout lands ever

TABLE 1—Canada's Reserves, Production, Producing Wells, Drilling, and Refining in 1959

Item	Alberta	Saskatchewan	Manitoba	British Columbia	Yukon & N. W. Territories	Ontario	Quebec	New Brunswick	Total Canada
***Proved reserves of liquid hydrocarbons at end of 1959, thous. bbls.**	**3,362,801**	**510,712**	**23,054**	**42,698**	**51,970**	**7,971**	.....	**63**	**3,999,269**
Crude Oil	2,898,878	495,787	23,054	19,401	51,970	7,971	.....	63	3,497,124
Natural gas liquids	463,923	14,925	.....	23,297	.....	.....	.....	.....	502,145
***Gas reserves, end of 1959, million cu. ft.**	**23,300,669**	**1,235,592**	**1,959**	**1,825,238**	**32,063**	**208,967**	.....	**848**	**26,605,336**
Crude oil production in 1959, bbls.	**129,962,195**	**47,442,468**	**5,056,075**	**866,234**	**421,894**	**1,004,298**	.....	**14,478**	**184,767,642**
Barrels daily	356,061	129,979	13,852	2,373	1,156	2,752	.....	40	506,213
Crude oil wells, end of 1959, producing	**8,280**	**3,447**	**730**	**37**	**62**	**1,430**	.....	**16**	**14,002**
Capable of producing	9,216	4,099	876	59	.....	.....	.....	.....	14,250
Wells completed in 1959	**1,577**	**826**	**47**	**110**	**9**	**281**	**6**	.....	**2,856**
Oil	877	523	30	20	1†	19	.....	.....	1,470
Gas	242	9	.....	44	.....	100	.....	.....	395
Dry	458	294	17	46	8	162	6	.....	991
Footage drilled in 1959	**8,809,544**	**3,229,961**	**107,025**	**614,861**	**30,521**	**402,867**	**12,066**	**1,615**	**13,208,460**
Wells drilling at end of 1959	**185**	**25**	**4**	**36**	**5**	.....	.....	.....	**255**
Number of refineries in 1959	**10**	**9**	**4**	**6**	**1**	**7**	**5**	**1**	**43**
Daily crude charging capacity, bbls.	91,620	71,000	35,000	100,000	1,300	252,530	264,500	300	816,250
Daily average crude runs to stills, bbls.	72,623	49,948	30,140	64,377	1,260	208,000	257,000	100	683,448

***Estimates of proved reserves are from Canadian Petroleum Association.** **†Oil and gas discovery in Yukon Territory—not completed.**

transacted, the well flowed at rates up to 8 million cubic feet per day during production tests conducted in March and April, 1960. The lands, amounting to more than 1¼ million acres, were acquired from a group headed by Canada Southern Petroleums Limited.

Other exploration in the Territories includes the most northerly test ever attempted. That well, being drilled by Amerada Petroleum, Ohio Oil Company and Hudson's Bay Oil & Gas Company Limited, is 45 miles north of the Arctic Circle, 85 miles north of the Chance No. 1 discovery well and 85 miles west of Arctic Red River, the only habitation for many miles.

VAST NEW B.C. GAS RESERVES

The oil and gas industry of Canada's most westerly province is having growing pains. While it was the first province to have large scale natural gas export to the U.S., deliverability has become quite a problem.

Production in the Ft. St. John area has been declining rapidly. However, this problem shortly will be overcome as Westcoast Transmission Company is planning a major extension to tap large new reserves at Kotcho Lake and Petitot River.

These two new finds, about 60 miles apart, are located 50 miles northeast and 70 miles north-northeast, respectively, of the Fort Nelson townsite. Both tapped the Middle Devonian for huge potentials.

In fact, the Kotcho Lake well is said to rival Alberta's Berland River strike which has a calculated open flow in excess of 1½ billion cubic feet daily.

A successful step-out to the Kotcho Lake discovery drilled this year by Pacific Petroleums Limited, was completed with a potential of 105 million cubic feet per day, added further important reserves to that region. An extension to the other area, meanwhile, also proved successful by flowing at a rate of 185 million cubic feet per day.

Prolific new discovery. Other indications of further large reserves in the same zone are being found near the Fort Nelson townsite.

One well, seven miles south of the town, found such high pressures in the Slave Point zone of the Middle Devonian that the operator feared a blow-out if drill pipe were removed from the hole. The drill-string was used instead of production casing and the well completed through it. From a 364-foot continuous dolomitic section, an absolute open flow potential was calculated at 135 million cubic feet per day.

Frank M. McMahon, president of Westcoast Transmission, recently stated that because of last season's drilling, it is estimated that upwards of 2 trillion cubic feet of new gas reserves have been located in the area.

Exploratory drilling in the region to date has maintained the remarkable ratio of one successful well for every two wildcats drilled.

TABLE 2—Forecast of Wells and Footage to Be Drilled in Western Canada

Period	Wells			Footage		
	1960	1959	% Dif.	1960	1959	% Dif.
2nd Half, Forecast	1,150	1,353	—15.0	6,330,750	6,666,609	—5.0
1st Half, Actual	1,184	1,216	— 2.6	6,420,366	6,125,303	+4.8
Year	2,334	2,569	— 9.1	12,751,116	12,791,912	—0.3

TABLE 3—Drilling in Western Canada in First Half of Year

*Province and Year (First Half)		Wells Completed				Footage
		Oil	Gas	Dry	Total	
Alta.,	1960	470	95	241	806	4,904,602
	1959	379	105	222	706	3,914,208
B. C.,	1960	29	18	43	90	438,436
	1959	8	17	26	51	308,881
Sask.,	1960	159	5	73	237	971,022
	1959	294	4	138	436	1,840,327
Man.,	1960	22	.....	8	30	60,159
	1959	15	.....	4	19	45,986
Nw. T.,	1960	.....	1	20	21	46,147
	1959	.....	.....	4	4	15,901
Total,	1960	680	119	385	1,184	6,420,366
	1959	696	126	394	1,216	6,125,303

*Abbreviations: Alta., Alberta; B. C., British Columbia; Sask., Saskatchewan; Man., Manitoba: Nw. T., Northwest Territories.

TABLE 4—Rigs Operating in Western Canada at End of 1959, by Provinces, and by Owners

Item	Rigs
Data by Provinces—	
Alberta	185
British Columbia	36
Manitoba	4
Northwest Territories	5
Saskatchewan	25
Data by Owners—	
Contractors, Total	249
U. S. Contractors	70
Canadian Contractors	179
Oil Companies	6
Total, Western Canada	255

SWAN HILLS AREA EXPANDING

Further exploration in the Swan Hills region of Alberta, 110 miles northwest of Edmonton, added millions of barrels of oil reserves during the past 18 months.

Imperial Oil Limited found the same Beaverhill Lake zone productive in the Judy Creek region, 15 miles south of the Swan Hills pool, and the team of British American Oil Company Limited and Pan American Petroleum Corporation discovered production in the same horizon at Sarah Lake, midway between those two pools.

Imperial's Judy Creek discovery was completed flowing 926 barrels per day of light gravity oil, and since then another 25 wells have been completed successfully.

Step-outs from the Sarah Lake discovery, completed flowing 991 barrels per day, have been increasing to the extent that the productive area now is a part of the Swan Hills pool.

Although only three years old, the Swan Hills field, which was the first major discovery of Beaverhill Lake oil, has developed into a major producing region. There are 150 wells now on production and more than 3 million barrels of oil already have been produced.

New Cardium trend. Late in 1959 a Cardium oil discovery was made in the Carstairs region of southwest Alberta, about 35 miles northwest of Calgary.

Discovered by Cree Oil of Canada (1958) Ltd. and Canadian Export Gas and Oil Ltd., the find since has been developed into a fairly extensive trend—in direct line with two previous successes some 18 miles apart.

Foothills discoveries. Two wells in particular have highlighted activity in the Alberta Foothills area the past year.

The Pincher Creek area well, drilled by British American Oil Company Ltd., is only five miles north of the U.S.-Alberta border. The well, Lookout Butte 11-31, was completed at 12,648 feet after penetrating 658 feet

British American Oil Company's discovery well at Lookout Butte, 7 miles southeast of Pincher Creek gas field, Alberta, Canada. Drilled to 12,648 feet in early 1960, it tested a sustained flow of 22.4 million cubic feet of gas per day, with 94 barrels of condensate per million feet of gas, from 658 feet of gross pay in the Rundle formation.

of gross pay in the Mississippian (Rundle) horizon.

The well indicated an open flow potential of 31 million cubic feet per day, with 94 barrels of condensate per million cubic feet.

The other discovery, Texas Gulf Wildhorse Creek 6-22-31-10, found the first Mississippian at 7,144 feet and on a drill stem test of the interval 7,468 to 7,588 feet, flowed at a maximum rate of 8.2 million cubic feet daily. Drilling is now proceeding to lower objectives.

While the flow in itself was important, the most significant factor was the depth at which the productive Mississippian was found. Other wells in the district, which include the Shell Panther River 1 (87 percent sulfur content) 6 miles to the southwest, and the Shell Burnt Timber gas discovery 12 miles to the east, produce from the formation at depths some 3,000 feet greater than that of the new find.

Important D-3 reef find. A discovery in the northwest part of Alberta, near the British Columbia border, may emerge as a significant prolific Devonian D-3 gas find. Shell Oil Company's Worsley 14-19 test, still classified as a tight hole, was drill stem tested late last year at rates as high as 8 million cubic feet daily from a 177-foot interval of D-3 reef.

While the potential of the well has not been released, it is rumored to be very substantial and, in fact, could rate as high as the 1958 Berland River completion. The initial follow-up to the discovery was abandoned, but another test three miles to the east also found production in the same horizon and was completed with a calculated open flow of 160 million cubic feet per day.

Shell has been the only company to carry out development in the Worsely area. However, a new test by another operator recently was started which, if successful, would carry the trend to the northwest.

EASTERN CANADA ACTIVITY SLOWER

Ontario drilling slow; production up. Drilling activity during 1959 in the province, down an over-all 13 percent, showed the greatest decrease in development work with a reduction of 26 percent. This was offset somewhat by a 39 percent increase in offshore drilling on Lake Erie. A decrease in development land drilling in the Niagara area accounted for most of the reduced drilling.

Geophysical activity in Ontario dropped by 50 percent during 1959 since the greater portion of the Lake Erie survey was completed the previous year. Acreage holdings decreased 15 percent.

Production of natural gas and crude increased significantly during the year, with crude reaching a record volume of more than 1 million barrels.

Quebec activity slower. Continuing a trend started in 1959, activities in Quebec continued slow during 1959. Only six exploratory tests, all dry, were drilled in the province as compared with 13 drilled in 1958.

Some of the drilling was in the St. Lawrence Lowlands but the greater part of the exploratory work was in the Gaspe Peninsula. During 1959 one Gaspe well was deepened and at year-end another test was started. Land holdings in the Gaspe area were increased by more than 1 million acres during the year.

OIL AND GAS DEVELOPMENT IN MEXICO

Mexico . . . to meet sharply rising demand, oil and gas industries are being vigorously expanded

MEXICO CONTINUES to expand its petroleum industry vigorously. Oil and gas are being used in sharply increasing volumes. The country is rich in petroleum resources, and they are being actively developed by Petroleos Mexicanos (Pemex), the government oil company.

In 1959 there were increases over 1958 of 5.1 percent in production of oil (crude oil and natural gas liquids), 25.8 percent in natural gas production, 8.4 percent in proved reserves of liquid hydrocarbons, 7.4 percent in natural gas reserves, 16.4 percent in wells completed, 17.7 percent in footage drilled, and expansion and improvement of pipe lines and refineries.

These increases were on top of similar gains in 1958, when oil production was up 9.2 percent and natural gas output jumped 60.2 percent over 1957.

Drilling. For the future a further vigorous growth of petroleum development is expected. In the spring of 1960 some 48 new drilling rigs were being put into service in Mexico, where only about 96 previously were employed, providing a sudden 50 percent expansion of field development.

For 1960 Pemex has programmed the drilling of 623 wells to completion, an increase of 41.3 percent over the 441 completed in 1959. The program for this year calls for 117 exploratory wells and 506 development wells. On May 31, 1960, there were 133 drilling rigs working, including 96 Pemex rigs and 37 rigs operated by private contractors.

TABLE 1—Recent and Estimated Future Production of Oil in Mexico, by Years
(Crude oil and natural gas liquids.)
Source: Petroleos Mexicanos

Year	Barrels Daily	% Rise
Actual—		
1957	252,595	—1.7
1958	275,730	9.2
1959	289,749*	5.1
Estimated—		
1960	308,726	6.5
1961	333,000	7.9
1962	360,000	8.1
1963	389,000	8.1
1964	420,000	8.0

*Includes 264,090 bpd of crude oil and 25,659 bpd of absorption liquids.

Production. The expansion of drilling is being carried out by Pemex in response to growing demand for petroleum products and natural gas. To supply increasing market requirements, Pemex expects to increase production of oils (crude and natural gas liquids) by 6.5 percent in 1960, to about 308,726 barrels daily from 289,749 in 1959. For the four years after 1960, Pemex estimates, oil production will need to be increased approximately 8 percent annually. On that basis, it would climb to 420,000 barrels daily in 1964. That would be, within five years, an increase of 130,000 barrels daily or 45 percent in oil output over the 289,749 bpd of 1959.

Eight to 12 new petrochemical plants were scheduled to be under construction in Mexico during 1960. They will produce three main classes of products: ammonia, carbon black, and artificial fibres. Nearly every refinery and natural gasoline plant has space set aside for expansion.

A large gas pipe line was being built in the spring and summer of 1960 to deliver natural gas from fields of Tabasco and the Isthmus of Tehuantepec northwestward to Mexico City and intervening points. A gas line from Reynosa near the United States border to Monterrey was extended to Torreon. More crude oil and products pipe lines also are being built, to take advantage of new fields and more economically distribute gasoline and other products.

Exploration. To help assure the fulfillment of greatly increased demand for oil and gas in future years, Pemex is actively searching for new fields. It is currently employing over 40 exploration parties in geological and geophysical work.

Exploratory work has continued to be concentrated mainly along the coastal plain of the Gulf of Mexico, from the United States border down through the Isthmus and the state of Tabasco. That region holds all present producing fields and affords the most promising possibilities of additional fields. Some geophysical work continued, however, in Baja California and Chihuahua, and on the Yucatán peninsula.

TABLE 2—Production of Crude Oil, Natural Gas Liquids, and Natural Gas, and Producing Wells, in Mexico

Source: Petroleos Mexicanos

DISTRICT	Production in 1959						Production per Day In April, 1960			Total Wells Drilled To End of 1959	Wells at End of 1959					
	Crude Oil		Natural Gas Liquids		Natural Gas						Producing Oil					
	Total Bbls.	Bbls. Daily	Total Bbls.	Bbls. Daily	Total MM Cu. Ft.	MM Cu. Ft. Daily	Crude Oil, Bbls.	Natural Gas Liquids, Bbls.	Natural Gas, MM Cu. Ft.		Flowing	Pumping	Gas Lift	Total	Producing Gas	Service
North Zone	16,340,765	44,769	1,907,774	5,227	123,370	338.0	34,135	5,707	358.0	662	788	100	2	890	166	8
Northeast District	1,029,931	2,822	1,897,944	5,200	110,812	303.6	2,823	5,689	321.7	387	47	...	...	47	166	8
North Dist. (Ebano-Panuco, etc.)	10,433,167	28,584	...	...	10,169	27.9	16,917	...	28.1	164	468	96	2	566	...	...
South Dist. (Old Golden Lane: Cerro Azul, etc.)	4,877,667	13,363	9,830	27	2,389	6.5	14,395	18	8.2	111	273	4	...	277	...	...
Central Zone	60,834,618	166,670	2,563,289	7,023	89,298	244.6	152,907	6,817	210.3	1,069	388	15	234	637	5	37
Poza Rica District	49,821,848	136,498	2,563,289	7,023	82,632	226.4	123,273	6,817	195.5	768	264	8	234	506	...	37
Nueva Faja de Oro Dist. (New Golden Lane)	9,380,528	25,700	...	...	6,396	17.5	27,598	...	14.4	235	110	...	...	110	...	...
Vera Cruz District	1,632,242	4,472	...	...	270	0.7	3,036	...	0.4	66	14	7	...	21	5	...
South Zone	19,217,661	52,651	4,894,369	13,409	116,124	318.2	64,481	13,245	336.9	1,077	305	375	87	767	40	14
Isthmus of Tehuantepec (Salt Dome fields)	8,156,156	22,346	89,819	246	4,998	13.7	19,797	262	14.8	646	76	375	50	501	2	...
Tabasco District	11,061,505	30,305	4,804,550	13,163	111,126	304.4	44,684	12,983	322.1	431	229	...	37	266	38	14
Total, Mexico	96,393,044	264,090	9,365,432	25,659	328,792	900.8	251,523	25,769	905.2	2,808	1,481	490	323	2,294	211	59

In 1959, Mexico had 368 party months of geological and geophysical exploration, including 104 surface geology, 204 seismograph, and 60 gravity. These totals all equaled or slightly exceeded those of 1958.

Discoveries. Through completion of 82 new field wildcats, 11 new fields (9 oil, 2 gas) were discovered in Mexico in 1959. They included 1 gas field in Northeast Mexico in the Eocene trend; 5 oil fields in the Tampico Embayment, producing from Cretaceous and Jurassic limestones; and 1 gas field and 4 oil fields in the Isthmus-Tabasco region, productive from Miocene sands. One Tabasco oil discovery was off shore.

Peñalva gas field, near Dr. Coss, Nuevo Leon, was discovered by E. W. Pauley's Peñalva 101, completed in Wilcox sand at 3,766-3,783 feet.

In the Tampico region Pemex opened 5 new oil fields. Barcodón 102, 25 miles northwest of Tampico, yielded gas from Jurassic at 5,545-5,587 feet and 940 barrels per day of oil from Lower Tamaulipas (Cretaceous) at 4,370-4,400 feet. Miquetla 1, 25 miles northwest of Poza Rica, Veracruz, produced 170 bpd from Tamabra limestone (Cretaceous) at 6,463-6,519 feet. Paso de Oro 1, 16 miles southwest of Tecolutla, yielded 1,670 bpd from Tamaulipas at 9,269-10,046 feet. Tres Hermanos 103, 10 miles northwest of Los Naranjos, produced 250 bpd from Jurassic at 6,952-7,060 feet. Zapote Viejo 1, 26 miles southwest of Pánuco, yielded 138 barrels oil with gas from Tamaulipas at 7,806-7,881 feet.

In the Isthmus, Santa Rosa oil field, 9 miles east of Coatzacoalcos, was opened by I. D. Co. Santa Rosa 101, yielding 94 bpd from Encanto (Miocene) sands at 1,007-1,066 feet.

In Tabasco, C. I. M. A. Santa Ana 239, 45 miles east-northeast of Coatzacoalcos, opened Santa Ana offshore oil field, yielding 1,550 bpd after dual completion in Encanto (Miocene) sands around 8,700 and 9,500 feet. Farther east, 37 miles northwest of Villa Hermosa, Pemex discovered Tupilco oil field with a 620 barrel well in Lower Miocene at 9,678-9,695 feet. Still farther east, 14 miles northeast of Ciudad Pemex, Cobo 1 of Pemex yielded gas from Lower Miocene around 5,000 feet. About 8 miles northwest of Cobo 1, Pemex Hormiguero 1 produced 943 bpd from Lower Miocene at 8,130-8,150 feet.

TABLE 3—Estimated Proved Reserves in Mexico at End of 1959

Source: Petroleos Mexicanos

Item	Amount
Liquid hydrocarbons, bbls.	**2,722,900,000**
Crude oil	2,458,252,000
Natural gas liquids	264,648,000
Natural gas, thous. cu. ft.	8,058,731,000
Natural gas, bbls. equivalent*	**1,611,746,000**
Total oil and gas, in bbls.	**4,334,646,000**

*Calorific equivalent to crude oil at the rate of 5,000 cubic feet = 1 barrel.

TABLE 4—Drilling in Mexico, by Years

Source: Petroleos Mexicanos

Year	Wells Completed				Wells Drilling, Year End
	Development	Wild Cats	Total	Footage	
1957	281	108	389	2,513,160	68
1958	303	76	379	2,636,906	75
1959	359	82	441	3,102,435	96
1960 Plan	506	117	623	4,382,805*	133†

*Computed by WORLD OIL on basis of average depth in 1959. †Drilling rigs working on May 31, 1960, including 96 Pemex rigs and 37 rigs of private contractors.

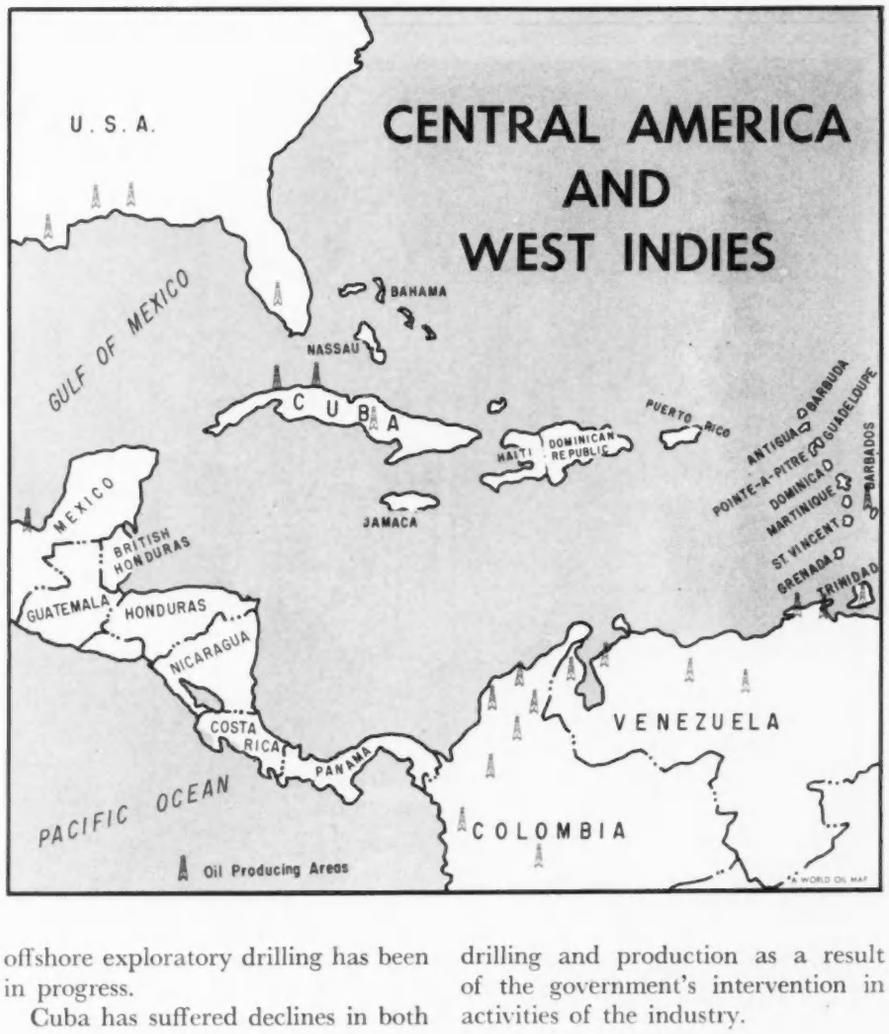
TABLE 5—Development Wells and Wildcats Completed in Mexico in 1959, by Areas

Source: Petroleos Mexicanos

Item	Number
***Total Wells**	**441**
Development Wells	**359**
North Zone	102
Northeast District	36
North Dist. (Ebano-Panco, etc.)	59
South Dist. (Old Golden Lane: Cerro Azul, etc.)	7
Central Zone	103
Poza Rica District	87
Nueva Faja de Oro Dist. (New Golden Lane)	15
Vera Cruz District	1
South Zone	155
Isthmus of Tehuantepec	39
Tabasco District	116
New Field Wildcats	**82**
Productive	11
Dry	71
Northeastern Mexico	15
Productive	1
Dry	14
Tampico Embayment	41
Productive	5
Dry	36
Vera Cruz Embayment	3
Productive	...
Dry	3
Isthmus and Tabasco	23
Productive	5
Dry	18
New Field Discoveries	**11**
Oil	9
Gas	2
Northeast Mex. (Penalva, gas)	1
Tampico Embayment (All oil)	5
Ebano-Panuco Dist. (Barcodon, Zapote Viejo)	2
Old Golden Lane (Tres Hermanos)	1
Poza Rica Dist. (Miquetla, Paso de Oro)	2
Isthmus (Santa Rosa, oil)	1
Tabasco (Cobo, gas; Hormiguero, oil; Santa Ana, off shore, oil; Tupilco, oil)	4

*Total footage, 3,102,435 feet; average depth per well, 7,035 feet.

Caribbean Region . . . activity lagging in Central America and West Indies



THERE IS currently a lagging of interest in petroleum exploration and development in the countries and islands ringing the Caribbean Sea. Central America has no established oil and gas fields, and the search for fields has been discouraged by the prevailing surpluses of oil in other lands. The islands of the West Indies lately have had a similar experience, and development has been limited largely to drilling in the proved fields of Trinidad.

In Central America, limited wildcatting is scheduled again in 1960 in Guatemala, Honduras, and British Honduras, where wildcats completed in 1959 totaled 4, 1, and 2, respectively. No drilling is under way in Nicaragua, Costa Rica, or Panama.

While drilling in Trinidad was concentrated last year principally in proved fields, there was some exploratory drilling. A new offshore field was discovered in 1959, and further offshore exploratory drilling has been in progress.

Cuba has suffered declines in both drilling and production as a result of the government's intervention in activities of the industry.

Central America . . . exploration is held down by current world surplus of oil

CENTRAL AMERICA in 1959 was relatively inactive in petroleum exploration. Interest of operators was held down by the world surplus of crude oil and the earlier lack of oil finding success in that region.

In Guatemala four dry holes were drilled in 1959 and early 1960, and at mid-year 1960 the country remained without commercial production of oil or gas. A wildcat will be drilled later this year by Ohio Oil Company. Only limited geological and geophysical work is in progress.

A 7,000-foot wildcat in Honduras in 1959 offered some encouragement, and several additional tests are planned for 1960 and 1961.

In British Honduras two wildcats were drilled by Phillips Petroleum Company, which plans to drill an additional well this year.

No drilling was reported in Nicaragua in 1959 or 1958. Panama also was without drilling in 1959, after having had some in 1958. Costa Rica had limited wildcat drilling in 1958 and 1959.

Br. Honduras

PHILLIPS PETROLEUM COMPANY drilled two exploratory tests and conducted extensive seismic-geological work in southern British Honduras last year. The company thus became the most active operator in the area. Both wildcats were dry and abandoned: Punta Gorda 1, located three miles northwest of the town of Punta Gorda, at 10,750 feet, and Machaca 1, located about 7½ miles northwest of Punta Gorda 1, at 7,872 feet.

The company expects to drill an additional well in 1960, based on recent seismic and geological surveys. By drilling these tests, Phillips earned a checkerboard spread out of Gulf Oil's acreage under terms of a farmout agreement.

Gulf-Shell, previously the most active operator in the country, drilled no wells in 1959.

In mid-1960, licenses covering 1,000 square miles each in northern British Honduras were approved for Sinclair-British Petroleum Exploration, Inc., and Standard Oil Co. Esso also plans to build a deep sea terminal in the country this year.

A drilling location in the Point Fortin area of Trinidad.

Guatemala . . . four dry holes were drilled in 1959. Ohio Oil has scheduled wildcat for this year

PROSPECTS do not appear so bright in Guatemala in 1960 as in the past few years. Four dry holes were drilled in 1959 and early 1960. As of July 1960, no commercial oil or gas production had been discovered.

Petroleum Investments Overseas, Ltd. (Shell), completed Laguna Blanca 1, between Fallabon and Flores in El Peten, as a dry hole at 3,971 feet in July 1959. As reported previously, Compañía Guatemala California de Petroleo (Standard Oil Co. of California), abandoned its test in the Livingston block in eastern Izabal at 8,300 feet.

Guatemala Atlantic Corp. cable tool drilled its San Fransisco 1A in Peten to 6,000 feet where it was declared dry and temporarily abandoned. Plans are to deepen the well some time in 1960. The Ohio Oil Company of Guatemala abandoned its Chinaja 1 at 10,806 feet total depth in the state of Alta Verapaz in March 1960.

At present, only one well is scheduled to be drilled in Guatemala in 1960. Ohio Oil will spud the test on the San Roman structure approximately 17 miles from Chinaja 1.

Exploration activity currently in mid-1960 was limited largely to geological work. Signal Oil and Gas, which held a 20 percent interest in the Livingston test, expects to complete its field work in Peten this year. Seismic activity has decreased, with only one crew operating in mid-1960.

New concessions were granted during 1959-60 to Plymouth Oil Co. Also, Delhi-Taylor Oil Corp. has applied for approval to take a farmout from Texaco, which owns 45 percent interest in a 1.3 million acre concession in the northwest corner of Peten. Puerto Barrios Petroleum Right 27 has been surrendered by Standard of California, Atlantic, Tidewater, Sohio, Signal and Bandini.

Costa Rica

THERE WERE three dry wildcats drilled in Costa Rica in 1959 and early 1960. The wells were drilled by Gulf Oil Corporation on Union Oil Company of California's concession. Gulf earned a 50 percent interest in the concession by drilling the tests.

Porvenir 1, located about 12 miles south of Puerto Limon, was abandoned in mid-1959 at a total depth of 6,775 feet. Limon 1, at Puerto Limon, was declared dry at 10,181 feet early in 1960. The third well, El Tigre 1, was located about 10 miles south of Puerto Viejo. It was dry and abandoned at 9,223 feet in June 1960. All of the tests were located in Limon Province.

In mid 1960, the Gulf-Union partners planned to drill Telirie 1, located about 30 miles west of Puerto Viejo.

Honduras

ONLY ONE EXPLORATORY WELL was drilled in Honduras in 1959. Petrolera Hondureña S. A., drilled the 6,947-foot wildcat, near Puerto Lempira in Gracias a Dios Department, on the basis of a gravity survey, which revealed several good anticlinal possibilities in the area. Results of the test were not disclosed.

Petrolera plans to drill four additional test wells in the Taulabe area of Comayagua in 1960-1961, on a farmout basis, to test Jurassic and lower Cretaceous formations.

A deep test on a large structure near Atima in southwestern Santa Barbara is expected to be drilled in 1961.

The Honduran congress is expected to revise the complicated new petroleum law now under consideration. Passage is expected in November 1960.

West Indies . . . activity is limited mainly to Trinidad. Government action sharply cuts work in Cuba

PETROLEUM DEVELOPMENT in the West Indies currently is limited principally to Trinidad and its adjacent waters. Cuba has been in the headlines prominently, but its oil development has been seriously curtailed through the political complications. Outside those two countries, there is very little activity.

Production was increased in Trinidad in 1959, although fewer wells were drilled than in 1958. The drilling included a substantial number of development wells in established fields, where large proportions of wells completed were productive. A new offshore field was discovered during 1959, and several other offshore areas were tested by drilling.

A deep test in the Bahamas was abandoned. A wildcat was due to be drilled in 1960 in the Dominican Republic. Exploration activity on the island of Barbados has been discontinued. Grand Cayman island (British) will be the scene of a four-well drilling program in 1960.

Bahamas

CAY SAL 1 was abandoned at 18,906 feet early in 1959. This deep test, located 180 miles southwest of Nassau, was drilled by Bahama California Oil Company and Bahamas Gulf Oil Company. The well was drilling at 15,131 feet at the start of 1959, hence 3,775 feet of hole was drilled in the Bahamas last year. No other activity was reported.

Cuba . . . production down 43.2 percent; new oil monopoly drilling first well

CUBA'S RED-TINTED crude oil may look attractive to the country's leaders, but it is playing havoc with the rest of the nation.

Despite government claims that imports have been averaging better than 70,000 barrels per day, reliable sources indicate that Russian shipments of crude oil averaged only 20,000-25,000 barrels daily during July, far below the country's normal 65,000 barrels per day requirement. During the latter part of the month, a Cuban tanker stopped at three Gulf Coast ports (Corpus Christi, Galveston, New Orleans) in a vain attempt to fill its holds.

Predictions are that Cuba's petroleum requirements have dropped considerably with the virtual elimination of tourists and slowdown in industrial activity. Even so, the country's fuel and lubricant needs are certain to become more critical, even if Russia eventually provides enough tankers to fill the petroleum void.

Lubricant problems. Shortage of petroleum isn't Cuba's only problem. The nation's new oil monopoly, Institute of Petroleum, is experiencing serious problems in keeping machinery lubricated.

Cuba imports nearly all of its lubricants. Some specialized lubricants already are in short supply. And in late July, experts stated that stocks were far short of the 30-day reserves on hand when the Shell, Texaco, and Jersey Standard refineries were confiscated on June 29 and July 1.

Also, the high sulfur content of Russian diesel fuel is rapidly damaging valves and other parts of tractors and other engines. Replacement parts for refineries are a growing problem. Russian crude oil has a high salt content that eventually coats tubing to the extent that much higher temperatures than normal are required for processing—making it necessary to replace parts more often.

Cuba's choice of a bed partner was well summed up recently when an observer remarked, "Fidel says he is getting Soviet oil cheap, but by the time he pays the extras, including the cost of refinery replacements and repairs to engine parts, he may wish he had stayed with Venezuelan oil."

Production down. Cuba's 210 producing wells totaled only 534 barrels per day during 1959, down 43.2 percent from the 1958 average of 941 bpd.

According to reports, there was only a slight decline in production during the first half of 1960, and total figures for the rest of the year will probably be slightly under 1959 levels.

Drilling activity drops. Ten dry wildcats and two development wells were drilled during 1959, totaling about 26,000 feet.

Only 3,000 feet of hole was drilled during the first half of 1960. However, the Petroleum Institute reported on June 30 that it had acquired drill-

TABLE 1—Crude Oil Production, Producing Wells, and Development Drilling in Cuba in 1959, by Fields

FIELD	Province	Type	Crude Oil Production: Barrels Daily		Crude Oil Production: Total Barrels		Crude Oil Producing Wells at End of 1959			Field Wells Completed in 1959: Wells				Field Wells Completed in 1959: Total Footage	Field Wells Drilling, End 1959
			1959	1958	1959	1958	Flowing	Pumping	Shut In	Oil	Gas	Dry	Total		
Bacuranao-Cruz Verde	Havana	Paraffin	60	146	22,085	53,329	..	13	..	1	..	9	10	.....	
Motembo	Las Villas	Naphtha	8	9	2,995	3,435	..	170†	..	1‡	..	1	2	.....	1
Jarahueca	Las Villas	Paraffin	26	66	9,475*	23,997	..	6	..	..	..	..	..	.....	..
Jatibonico	Camaguey	Asphalt	373	580	136,254	211,453	..	16	..	1	..	..	1	.....	..
Santa Maria del Mar	Havana	Paraffin & Asphalt	25	30	9,095	10,863	..	3	..	..	..	..	..	.....	..
Catalina	Camaguey	Paraffin	0	12	0	4,552	..	..	1	..	..	..	..	.....	..
Guanabo	Havana	Asphalt	41	98	14,943	35,903	..	2	..	..	..	..	..	.....	..
Total	.....	.....	534	941	194,847	343,532	..	210	1	3	..	10	13	26,000§	1

* Field shut in 6 months. † Boiling. ‡Naphtha. §Estimated.

ing rigs and was starting a drilling program.

The first well to be drilled by the Institute was spudded in on July 11, about 12 miles east of Habana Bay, with a projected depth of 2,500-3,000 feet. The well is on state land adjoining the Don Manuel concession, south of the town of Barreras. Evidently this is a strip of land not covered by prior concessions.

The government has yet to announce exploration plans. There was no geophysical activity during the first six months of 1960.

TABLE 2—Drilling of Wildcats in Cuba in 1959

PROVINCE	Wildcats Completed in 1959				Wildcats Drilling, End 1959
	Oil	Gas	Dry	Total	
Oriente	..	..	4	4	..
Camaguey	..	..	2	2	..
Las Villas	..	..	1	1	..
Matanzas	..	..	..	..	..
Habana	..	..	2	..	..
Pinar del Rio	..	..	1	1	..
Total	..	..	10	10	..

Puerto Rico

KEWANEE INTERNATIONAL OIL CO. spudded its first test last November about 20 miles from Guayanilla on a 200,000-acre concession on the south coast of the island held by a group led by David L. Gordon, president of Maritime Oil Co. of Houston, Texas. By the end of December, the well had been drilled below 6,000 feet. It was to be deepened, and the drilling program was to be continued during 1960.

The Gordon group's concession is a rectangular block extending 5 miles north and 9 miles south of latitude 18° N., and extending from just west of Ponce eastward to longitude 66° 15′ W. About half of the concession area is offshore.

Dom. Republic

KILOMETER 19-2 WELL was being drilled below 5,292 feet on a surface anticline five miles west of the old Maleno field at the end of December by Compañía Petrolera Dominicana. This test was spudded on November 22, according to AAPG *Bulletin* 44, No. 7 (1960). The location is near the south coast of the Island.

Another Dominican Republic wildcat is expected to be drilled in 1960.

Grand Cayman . . .

INDEPENDENT OPERATOR HARRY T. MCCLAIN et al of Houston, Texas, has recently been assigned exploration rights to the 350 square mile island by the British government. The operator plans to initiate a four well drilling program in 1960. The first well is due to be spudded in the northwest corner of the island in mid-year.

All tests are intended to explore Cretaceous formations. A geologic study has been made and surface indications of hydrocarbons have been reported. There was no oil or gas production on the island as of July 1960.

West Indies Federation . . .

PETROLEUM development in the West Indies Federation was limited in 1959 largely to Trinidad, where there are established important fields. Barbados heretofore has had some additional drilling, following the finding of gas condensate production. But work on that island has been stopped.

The West Indies Federation was formed in March 1958. It is composed of 10 British colonies, including Antigua, Barbados, Dominica, Grenada, Jamaica, Montserrat, St. Christopher-Nevis-Anguilla, St. Lucia, St. Vincent, and Trinidad-Tobago.

Crude oil production is being increased in Trinidad, despite curtailment of drilling, by concentrating development in proved fields. Exploration has been featured by offshore drilling.

Barbados

BARBADOS GULF OIL COMPANY has discontinued exploration activity on the island. The last well drilled, Morgan Lewis 1, had reached 14,723 feet at the start of 1959 and was abandoned early last year at 15,077 feet. Gulf's single gas condensate well, Spring Vale 1, has been assigned to the government-owned natural gas company. The well is producing into the local distribution system.

Trinidad . . . well completions continue to decline; production increases

FOLLOWING a three-year trend, Trinidad's well completion total declined while production increased during 1959.

Total completions declined from 314 wells in 1957 and 295 in 1958, to 278 last year. Of the 1959 completions, 244 were oil producers, 3 were gas and 31 were dry, for an 89.6 percent success ratio. Total producing wells decreased from 3,300 to 3,261 during the year.

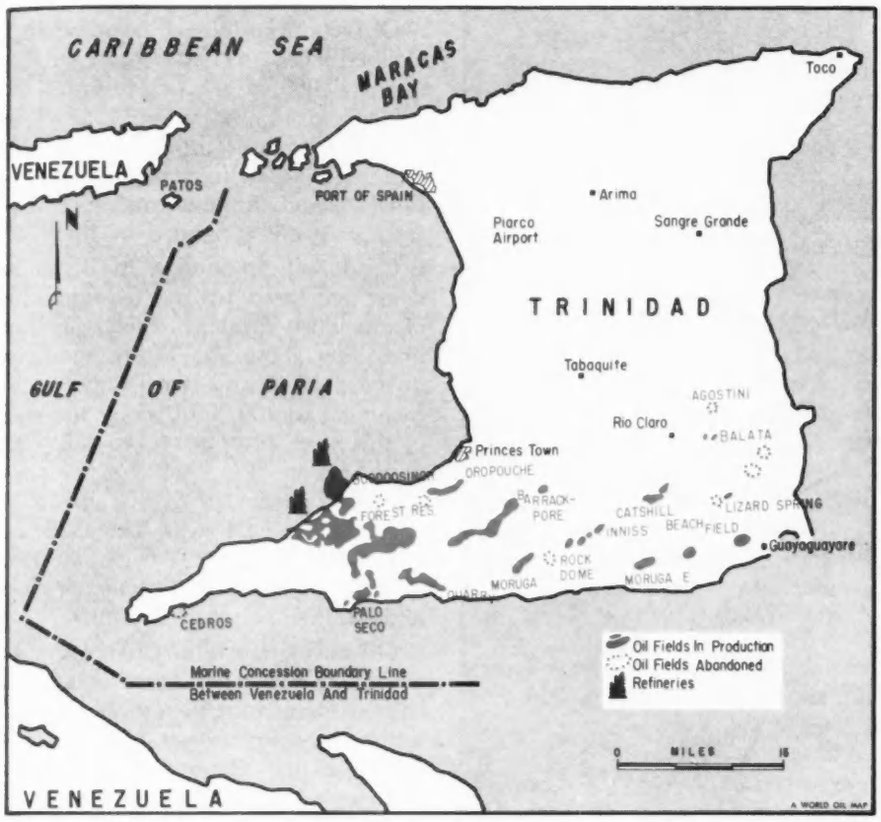
During the same three-year period, production increased from 93,326 bar-

TABLE 1—Crude Oil and Natural Gas Production in Trinidad, by Companies

COMPANY	CRUDE OIL PRODUCTION					Natural Gas Production (Million Cu. Ft.)	
	Total Barrels			Barrels Daily			
	1959	1958	Cumulative Through 1959	1959	1958	1959	1958
Apex (Trinidad) Oilfields, Ltd.	2,926,805	3,142,501	117,294,244	8,018	8,610	3,479	3,974
Dominion Oil, Ltd.	46,594	1,852	*	128	5	517	.....
C. D. Jones	1,964	.....	1,964	5	.....	.....	.....
Kern Trinidad Oilfields, Ltd.	1,146,809	1,143,262	23,787,460	3,142	3,132	898	592
Premier Consol. Oilfields, Ltd.	375,192	418,577	*	1,028	1,147	1,002	530
Shell Trinidad, Ltd.	7,435,519	7,996,730	148,237,767	20,371	21,909	17,683	16,210
Texaco Trinidad, Inc.	17,688,517	15,956,096	257,455,443	48,462	43,715	40,824	35,205
Trinidad Central Oilfields, Ltd.	1,468,872	1,628,107	*	4,024	4,461	8,464	8,267
Trinidad Northern Areas, Ltd.	3,772,423	1,981,076	7,998,722	10,335	5,428	3,620	1,934
Trinidad Pet. Dev. Co., Ltd.	6,056,091	5,086,858	78,452,984	16,592	13,937	15,476	12,478
Others, estimated	.....	.....	44,771,416	.....	.....	.....	.....
Total	40,918,786	37,355,059	678,000,000	112,105	102,344	91,963	79,190

* Included below with "others".

OIL FIELDS AND DRILLING ACTIVITY IN TRINIDAD



rels per day in 1957 and 102,344 bpd in 1958, to 112,105 bpd last year.

Footage drilled during 1959 totaled 1,446,566 feet, for an average of 5,204 feet per well. This compares with the 1958 total of 1,365,129 feet, for a 4,628-foot per well average. There were 29 wells drilling at the end of 1959, the same as one year previously.

Paria exploration increases. The east coast marine area is the newest prospect in Trinidad's exploration program.

There are an estimated 2-2½ million acres of continental shelf concession blocks that are expected to be auctioned off the east coast, plus 16,000 acres remaining in the Gulf of Paria. Nearly 2 million acres already have been leased to oil companies in the Gulf of Paria.

Dominion Oil Ltd. completed a new offshore field discovery in 1959, and drilled two more offshore appraisal wells. Off the east coast, sea bottom cores were taken, and a geological survey was carried out. Several geological surveys were conducted in the Gulf of Paria. Also, a small amount of surface investigation was conducted on land in the Montserrat, Mansanilla, and Mayaro areas.

Drilling activity. Apex (Trinidad) Oilfields Ltd. experienced severe mechanical difficulties in drilling the Cedros deep appraisal well, and abandoned it at 14,850 feet after encountering no oil sands. Apex operated three rigs in the Fyzabad field during the first half of 1959, and four during the latter half.

Kern Trinidad Oilfields used one drilling rig and completed eight producing wells during the year. Premier Consolidated Oilfields Ltd. used one contract rig intermittently and completed 13 wells, of which two were oil producers.

Shell oil operated three strings during the year and drilled 229,711 feet of hole, an increase of 13½ percent over 1958. About one string year was devoted to drilling seven regional appraisal wells in the Ortoire concession. The remainder of the rig time was used in development and outstepping in the Point Fortin, Penal, Innias, and Catshill fields, where 27 wells were drilled, only one of which was a dry hole.

Seven rigs were used by Trinidad Development Co. during 1959. One was used for appraisal or semi-appraisal drilling, two in the Moruga fields, and four were drilling in the main fields. Footage drilled was up 3 percent. Eighty-four wells were completed, of which 79 were producers.

Texaco completed 91 wells during the year, of which 7 were dry holes. Most of the drilling was concentrated in the Forest Reserve and Brighton areas, where 60 wells were completed. Twelve wells were completed on the marine drilling platform at Brighton, five of which were dual completions.

Secondary recovery operations by gas injection and waterflooding were continued by Texaco. Gas injection into certain Forest Reserve formations remained at an average of 25 MMcf per day. Waterflooding continued at Guayaguayare, and at Forest Reserve, where one rig started drilling in preparation for full scale injection in 1960.

TABLE 2—Crude Oil Production in Trinidad, in 1959, by Areas

FIELD	Barrels	Bbls. Daily
Brighton-Vessigny & adjacent marine area	2,580,935	7,071
Forest Reserve-Apex-San Francique-Point Fortin E.	12,358,319	33,858
Guayaguayare	1,254,645	3,437
Kern-Parrylands-Cruse	2,057,683	5,637
Palo Seco-Los Bajos	5,467,193	14,979
Penal-Barrackpore	3,600,294	9,864
Point Fortin-Pt. Ligoure	1,771,112	4,852
Soldado Marine	3,772,423	10,335
South Domoil	46,594	128
Quarry-Coora-Quinam-Morne Diablo	3,247,798	8,898
Moruga East	173,572	476
Moruga West	703,309	1,927
Balata-Bovallins	154,422	423
Cats Hill	1,350,159	3,699
Orepouche	231,083	633
Inniss/Trinity-Moruga N.	2,149,245	5,888
Total, Trinidad	40,918,786	112,106

TABLE 3—Wells in Trinidad in 1959 and 1958
(Completed, Drilling, Producing, and Shut In.)

ITEM	1959	1958
Wells Completed	278	295
Oil	244	256
Gas	3	.....
Dry	31	39
Percent Successful	88.8	86.8
Footage Drilled	1,446,586	1,365,129
Average Depth	5,204	4 628
Wells Drilling:		
End of year	29	29
Average during year	30	32
Wells Producing, End of Year	3,261	3,300
Wells Shut In, End of Year	2,198	.....

TABLE 4—Refining in Trinidad

ITEM	Bbls. Daily
Capacity, 1959	190,000
Texaco	140,000
Shell	50,000
Average Throughput:	
1959	189,600
1958	165,000

Argentina, Brazil and Chile Are Active in South America

Venezuela has large output despite drilling decline. Drilling increases in Colombia, and revives in Peru

CRUDE OIL production in Venezuela topped a billion barrels in 1959 for the second time, almost equaling the record 1957 output stimulated by the Suez crisis. Prolific new wells in Lake Maracaibo helped maintain crude oil reserves, despite near-record output and a decline in drilling.

Argentina's policy of making production contracts with private firms has been very successful, both in stimulating output by private companies and in spurring Yacimientos Petroliferos Fiscales (YPF) by introduction of more active competition. Important discoveries were being made in Comodoro Rivadavia, and the first oil and gas production had evidently been found in the Rio Negro (Colorado) Basin by YPF. Major oil discoveries were being made on the Argentine side of Tierra del Fuego, paralleling similar developments on the Chilean side.

Chile's crude oil production climbed to about 19,000 barrels daily in early 1960, after rising to 17,611 in 1959 from 15,254 bpd in 1958. The Magellan area is productive on the mainland as well as on Tierra del Fuego island. Refining and pipe line facilities were expanded in 1959.

Crude oil production in Brazil is being increased by the development of previously established fields. It was averaging about 75,000 barrels daily in early 1960, and is expected to be increased to 100,000 bpd by the end of this year. Output of about 65,000 daily average for 1959 was 24 percent above that of 52,000 in 1958. The Bahia field was extended in 1959. But no other oil field has been discovered, despite active exploration and drilling.

Oil development in Colombia was active in 1959, as some interest shifted there from Venezuela. Several additional companies started exploratory drilling. The number of wells completed increased considerably. Out of 36 wildcats drilled last year, 5 struck oil, 1 gas, and 30 were dry. Crude oil production climbed above 155,000 bpd in the spring of 1960 from an average of 146,778 in 1959.

Oil development in Peru lagged in the first half of 1959 because of low ceiling prices imposed on petroleum products. But drilling was revived in the latter half of the year after a change in the government and substantial raising of the prices of oils. For the year as a whole, both crude production and drilling were lower than in 1958.

The first pipe line across the Andes Mountains has been completed. It will move oil about 800 miles from the Camiri field of Bolivia to Arica on the northern coast of Chile. Exploration and drilling continue active in Bolivia, but production has been decreasing.

Formidable difficulties have been overcome in exploratory drilling in remote areas in Paraguay by a group of U. S. companies. They discovered gas but abandoned several wildcats, and have discontinued drilling.

Oil development in Ecuador, as in Peru, has been discouraged by unprofitable domestic ceiling prices imposed by the government. Crude oil production has been continuously declining in recent years.

Argentina . . . drilling boom moderates as nation nears self-sufficiency in oil

ARGENTINA is rapidly changing from a nation deficient in domestic oil and gas production to one with a surplus. In the amazingly short period since mid-1958, the country has put its oil industry in good order. Much remains to be done, but essential major projects have been accomplished. Only a severe, unforeseen political upheaval could undo this progress as of mid-1960.

Development drilling and new pipe line facilities in Comodoro Rivadavia, Neuquén, Tierra del Fuego, and Salta have increased output of crude oil and natural gas to a point close to the national demand for these fuels. Early in 1960 YPF announced self-sufficiency in crude oil output (small amounts of specialty crudes excepted) and that excess YPF-produced crude was being sold to private refiners. Next year all Argentine refineries will probably be operating entirely on domestic crudes, small amounts of specialty crudes again excepted. In addition, natural gas was replacing fuel oil for industrial use, power generation etc. and was also displacing manufactured gas for domestic use in Buenos Aires and other metropolitan centers.

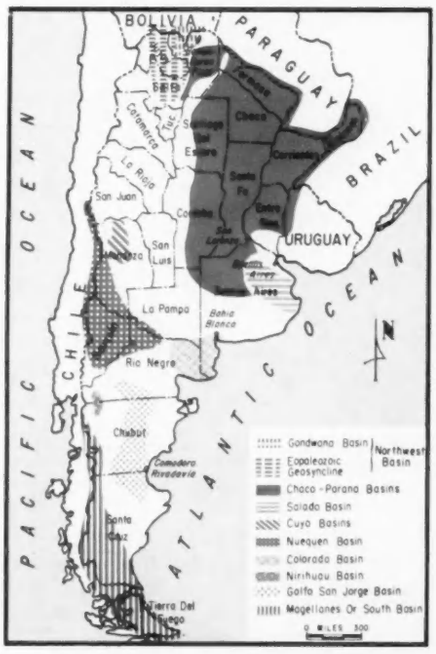
Owing to completion of pipe line facilities to move crude and condensate from the Salta fields to refining centers, and by continued boosts in crude output by YPF, Pan American, L-R Development, Inc. and other producers, production was expected to average almost 200,000 bpd this year, compared with 132,112 bpd last year and only 97,800 bpd in 1958.

Crude oil production amounted to 48,221,081 barrels in 1959 (Table 1), an increase of 35.1 percent over the 1958 rate. YPF's increase in 1959 was almost 30 percent over 1958, and new production by L-R and Pan American helped to swell the tide. Production, drilling, exploration, and pipe line developments are listed by companies in the following discussion.

YPF completed 402 wells in 1959, including 329 oil wells, and had 65 wells drilling at the end of December. Hence, wells were averaging less rig time than in previous years. At the same time, footage increased abruptly from 1,902,628 feet in 1958 to 2,426,400 feet last year. YPF's crude oil output continued to set new records in 1960. Production in early 1960 was running as high as 150,000 bpd.

Exploration continued with interesting results. YPF announced discovery of oil at about 900 feet in eastern Rio Negro province, near the border of La Pampa. The second well was said to have been completed in April 1960. This discovery may open the Colorado Basin to oil production. Gas was also reported at 1,500 feet. In the vast northeastern region (WORLD OIL, August 15, 1959, page 130) YPF was reported to have received three bids in mid-1959. One was from The Ohio Oil Company on an 11,500-square-mile area in northern Santiago del Estero and Tucuman provinces. The other was from Continental Oil Company, regarding an area in southern Santiago del Estero and northern Santa Fe. An Argentine company made a bid on two tracts in Buenos Aires province.

ARGENTINE SEDIMENTARY BASINS



Major pipe lines were completed and new projects were proposed. On December 13, oil entered the new 927-mile, 12-inch crude and condensate line from Campo Duran field in Salta to San Lorenzo. Initial flow was 16,000 bpd, to be boosted to 55,000 bpd later. On December 16 welding was completed on the 1,090-mile, 22/24-inch natural gas line from Campo Duran to Buenos Aires. Both lines were formally dedicated early in 1960. The behavior of the deep gas-condensate wells in Salta under full production conditions was being watched, to determine if previous reserves estimates will prove to be correct.

In mid-1960, YPF was considering plans to loop (in effect) the Campo Duran-Buenos Aires line with a second major gas line; and a proposal to build a pipe line to allow Salta gas to be exported to Chile was heard. YPF was also expected to request tenders on a $300 million, 1,000-mile, 30-inch natural gas line project to move 350 MMcf daily of Comodoro Rivadavia gas to Buenos Aires.

L-R Development, Inc. (Loeb Rhoades) continues an active drilling and production program which dates from late 1958. Sixty-nine wells had been completed by March 1, 1960 on three contract areas aggregating 118,608 acres in the Cuyo Basin of Mendoza, including 54 oil wells in La Ventana field and 5 in Punta de las Bardas, and 10 dry holes. In addition, L-R was drilling its third wildcat in a 1.2 million acre contract area in Comodoro Rivadavia in April 1960. Oil and gas shows were found there.

L-R was utilizing 5 drilling and 2 workover rigs. The Mendoza wells were being drilled to about 7,500 feet and completed as pumpers. Production had reached 15,000 bpd by last December and was being maintained at that rate in April 1960. A waterflood program was being considered at La Ventana.

Pan American International Oil Corp. boosted its oil production in the Chubut Basin (Comodoro Rivadavia area) from 4,500 to about 25,-

TABLE 1—Crude Oil Production and Drilling in Argentina in 1959

COMPANY[1]	Crude Oil Production				Wells Completed in 1959					Wells Drilling, Year End
	Total Barrels, in 1959	Bbls. Daily		% Diff. in 1959	Oil	Gas	Dry	Total	Total Footage (Feet)	
		1959	1958							
YPF	40,594,350	111,217	85,642	+29.9	329	13	60	402	2,246,400	65
L-R	2,773,437	7,598			40		7	47	330,000[2]	6
Dia.	2,743,196	7,516	7,924	— 2.6	8			8	46,607	1
PanAm	647,154	1,773			79		10	89	515,000	10
Esso	148,944[3]	408	774	— 47.3			2[4]	2[4]	11,246	2
Tenn.					4		1	5	35,000	3
K-McG					2			2	23,500	2
SAIP					4[2]		1[2]	5[2]	25,000[2]	5
Union							2[5]	2[5]	11,000[2]	1
Others	1,314,000[2]	3,600[2]	3,460	+ 4.0	10[2]		5[2]	15[2]	60,000[2]	2[2]
Total	48,221,081	132,112	97,800	+35.1	476	13	88	577	3,303,753	97

[1] Abbreviations stand for company names as follows: YPF—Yacimientos Petroliferos Fiscales; L-R—L-R Development, Inc.; Dia.—Diadema Argentina S A de Petroleo (Royal Dutch Shell interests); PanAm—Pan American International Oil Corp.; Esso (see footnotes 3 and 4); Tenn.—Tennessee Argentina S A; K-McG—Kerr-McGee Oil Industries, Inc.; SAIP—SAIPEN (a subsidiary of the Italian government agency Ente Nazionale Idrocarburi); Union—Union Oil Company of California. "Others" include the Argentine firms Astra Compania Argentina de Petroleo; Petroquimica; and Compania Rio Autel "El Sosneado". [2] Estimated. [3] Standard Oil Company (New Jersey)'s affiliated production firm in Argentina is Esso Sociedad Anonoma Petrolera Argentina. Of the 1959 crude output, 100,969 barrels was from Neuquen and 47,975 barrels from Salta. The latter figure covers the first four months only since Esso's Salta properties were transferred to YPF on April 20, 1959. [4] Drilled by Esso Argentina Inc. in Neuquen. [5] Oil reported in both wells but considered non-commercial.

000 bpd upon completion in March 1960 of a new pipe line to the coast. By that time Pan American had completed 150 wells on its million-acre contract area. More than 50 pay horizons, many of them thin lenticular sands, have been established at Cerro Dragon field. Pan American had 14 rigs in Argentina at the end of December. The new pipe line is 12/14-inch, spanning 83 miles between Anticlinal Grande and Cerro Dragon fields and YPF's terminal at Caleta Olivia.

Pan American expected to continue to utilize from 6 to 10 drilling rigs and 4 completion rigs in 1960. Work by one seismic and three surface geological parties was to continue this year, and from 8 to 10 new wildcat prospects were to be drilled.

Esso Argentina Inc. is conducting exploration in the Neuquén area and is building a 390-mile, 14-inch crude oil pipe line from Neuquén to Bahia Blanca for YPF.

The Royal Dutch Shell group is represented by several companies in Argentina, Diadema Argentina S A de Petroleo being an important crude oil producer (Table 1). Seismic work was proceeding in mid-1960 in the 7,360,000-acre coastal block in the Rio Negro (Colorado) Basin south of Bahia Blanca. Stratigraphic drilling was planned also. If YPF's Rio Negro discovery fulfills expectations, Shell's acreage may be enhanced.

Tennessee Argentina, S. A. is developing 3,435,000 acres on the Argentine side of Tierra del Fuego. A major discovery has evidently been made at La Sara. The firm's first test, La Sara South 1, found more than 200 feet of net oil sand at about 7,000 feet. The well was completed for 1,480 barrels daily. In March 1960, Tennessee reported completion of 7 oil wells and confirmation of 50 proven locations at La Sara. Seven other fields in the area were also considered to be commercial. Completion of pipeline and marine terminal facilities, scheduled for June 1960, was to allow large-scale production to begin. By March 1960, Tennessee had completed 12 wells, adding to the 29 already completed by YPF on Tierra del Fuego.

Other companies. The Italian firm SAIPEN was completing its drilling contract with YPF in mid-1960 and was negotiating for another. Five SAIPEN rigs were working in the south flank of Comodoro Rivadavia.

Kerr-McGee Oil Industries had drilled 20 wells as of April 1, 1960, and had completed 13 of them at the time. Union Oil Company of California began drilling late in 1959 on its 4-million-acre contract area composed of two blocks on the west side of Comodoro Rivadavia. By mid-1960 Union was drilling its seventh well. All tests thus far had been unsuccessful.

Bolivia . . . exploration and drilling by private companies continues after increasing in 1959

Oil production in Bolivia by Yacimientos Petroliferos Fiscales Bolivianos (YPFB), the only producer, continued declining, from 9,413 barrels per day in 1958 to 8,685 bpd in 1959. In the early months of 1960 output remained at about the same level, reaching in March a low of only 8,010 bpd.

OIL FIELDS AND PIPE LINES OF BOLIVIA

First trans-Andean pipe line, completed in 1960, will move oil 800 miles from Camiri field, Bolivia, to Arica, northern Chile on Pacific coast.

The formerly fast rising development by YPFB, the government agency, has been hampered by political unrest and resulting financial difficulties. Development was hindered and financial trouble was increased by several revolutionary movements, labor trouble and strikes, and serious disputes in the government party itself. The party was split by nomination of the known leftist labor leader, Mr. Lechin, head of the Central Obrera, as vice president of the Republic in the elections of June 1960. Exchange declined to around 12,000 bolivianos per dollar.

The pipe line to Arica in northern Chile was completed in March 1960. It is the first trans-Andean pipe line

in South America, connecting the Camiri field in the foothills east of the Andes, in a total length of nearly 800 miles, with the Pacific coast. It crosses the Cordillera at an altitude of 14,000 feet.

The last section of 218 miles length from Sica-Sica to Arica was completed by Williams Brothers in about one year at a cost of $12 million. But this pipe line, commenced with great enthusiasm and hopes for rapid development of Bolivia's oil resources, could not be profitable because of the lack of crude. About 5,500 bpd are consumed in the country. The balance has to be exported to Argentina and Brazil under binding obligations. Costs of railway construction from Yacuiba to Santa Cruz by Argentina and from Santa Cruz to Puerto Suarez-Corumba by the Brazilian government must be paid in oil.

Production. Bolivia's crude oil production amounted to 3,170,115 barrels or 8,685 bpd in 1959, against 3,435,830 barrels or 9,413 bpd in 1958, a decline of 18.2 percent. A total of 2,657,342 barrels or 7,280 bpd, was supplied by the Camiri and Guairuy fields, which remained the principal producers. Drilling has been successful also on the Itapirenda closure between Camiri and Guairuy, and two wells were producing. Production of Camiri-Guairuy fields, averaging 7,280 bpd, came from 75 producing wells, of which 67 were flowing and 8 pumping. Average yield per well was 97 bpd, a little less than in 1958.

In the small Sanandita field output of 12 pumping wells declined slightly to 86 bpd. One new well drilled was dry.

In the Toro and Bermejo fields in the south, on the Argentina border, output increased 15.3 percent to 1,319 bpd from 1,144 in 1958. The oil came from 26 producing wells. Eight new wells were completed, of which 6 yielded oil. However, on the Arrozales and Barredera domes of the same structure, drilling has not yet been successful, and 5 wells drilled so far have been abandoned.

Cumulative output of YPFB exceeds 25 million barrels. But considerable reserves can still be developed.

Drilling. YPFB completed 26 wells in 1959, about 20 percent less than in 1958. Of them 20 yielded oil, 1 gas, and 5 were dry. Total footage drilled by YPFB amounted to 138,688 feet, slightly more than in 1958. Average depth was 5,334 feet. At the end of the year 8 rigs were active in Camiri, 2 in Sanandita, and 3 in Toro-Bermejo.

Private companies. Exploration and drilling by private companies was active and augmented considerably. Since starting operation in 1958, they have drilled 14 wildcats. However, only a well in the Madrejones area resulted in production.

Bolivian Gulf Oil Company, the most active operator, employed three rigs. Its El Cedro 1, located 15 miles northwest of Santa Cruz, was spudded in June 1959, and in March 1960 it was temporarily suspended at 14,861 feet after having yielded gas shows. The rig was moved 15 miles west-northwest to Coranda 1, which was spudded April 10, 1960, and later was drilling below 3,000 feet, with an objective of 12,000 feet. Yoay 1 in the Santa Cruz region was abandoned at 15,257 feet. Parapeti wildcat was abandoned at 7,100 feet. Mitaigua 1, located 40 miles southeast of Camiri field, was spudded in November 1959, reached 12,010 feet in early 1960, swabbed shows of oil, and in May 1960 was testing. The rig will be moved 8 miles west-northwest to drill Boyuibe 1, a 12,000 foot test. Victoria 1, located 50 miles southeast of Camiri field, was spudded in November 1959, and abandoned dry at 7,236 feet in January 1960. Victoria 2 was drilling below 7,000 feet in May 1960.

Chaco Petroleum Co., subsidiary of Tennessee Gas Transmission Co., associated with Union Oil & Gas Corp., Lion Oil Co., and Murphy Oil Co., completed its first well in 1958 on the Monos anticline, where Glenn McCarthy had struck oil and gas, but abandoned it as non-commercial. On the Agua Salada overthrust on the border of the Chaco, it drilled one wildcat to 9,532 feet in 1958 and one to 14,958 feet in 1959, and both were abandoned. A third wildcat, Palo Marcado, has been spudded.

Bolivian Oil Co., formed by Fish Engineering Co., and several associates, drilled successfully in the Madrejones area on the Argentine border, employing Big Chief Drilling Co., of Dallas as contractor. The first well, completed at 13,667 feet, reportedly yielded 3,000 bpd when tested. The second well, to 13,680 feet, which had a fishing job, is expected also to be a producer. The third well was drilling in March 1960 at about 12,000 feet.

The oil, the first important new discovery in Bolivia, will be transported by the new pipe line, built also by Fish Engineering Co., from the neighboring Campo Duran field in Argentina to San Lorenzo refinery on the Parana river, upstream from Rosario.

The other private companies active in Bolivia include Bolivian Shell; Bolivian California Oil Co. (Standard of California); Bolivian Petroleum Co., in which Atlantic Refining took an 80 percent share; Bolivian American Petroleum Co., formed by Consolidated Cuban Oil Co.; Andes Oil Co., subsidiary of Pure Oil Co. and associates; White Eagle International of Tulsa; and Cataract Mining of Panama. They continued surface exploration by geological, gravimetric, and seismic surveys. Over 30 crews were active. An aereophotographical survey, jointly undertaken by several companies, was completed.

When the political and social situation improves, drilling by the private companies will certainly be accelerated, and the already successful drilling in the Madrejones area should substantially increase Bolivia's oil output in the near future.

Crude Oil Production and Drilling in Bolivia in 1959, by Companies and Fields

Company and Field	Crude Oil Production in 1959 (Bbls.)		Producing Wells at End of 1959			Wells Completed in 1959					Wells Drilling End of 1959
	Total	Daily	Flowing	Artificial Lift	Total	Oil	Gas	Dry	Total	Footage	
YPFB*											
Camiri & Guairuy	2,657,342	7,280	67	8	75	14	1	2	17	98,007	8
Sanandita	31,368	86		12	12			1	1	7,004	2
Bermejo and Toro	481,405	1,319	26		26	6		2	8	33,677	3
Total YPFB	3,170,115	8,685	93	20	113	20	1	5	26	138,688	13
Other Companies						1		3	4	50,982	6
Total Bolivia	3,170,115	8,685	93	20	113	21	1	8	30	189,670	19

*Yacimientos Petroliferos Fiscales Bolivianos.

EXPLORATORY WELLS DRILLED IN BRAZIL IN 1959

Tests were drilled in the Amazonas-Maranhao Basin in the north; the Sergipe-Alagoas Basin in the northeast; the Reconcavo Basin immediately south in Bahia, containing established fields; and farther southward down the coast in the Espirito Santo, Campos, and Paraná Basins.

Brazil . . . obtaining increased part of oil requirements from own production in active program

DOMESTIC CRUDE oil output supplied about 25 percent of Brazil's needs during 1959, and imports cost the nation an estimated $220 million. Some of the highly paraffinic crude, unsuitable for Brazilian refineries, was exchanged for Venezuelan crude.

However, the large increase in domestic production during the past few years and the rapidly increasing refining capacity have strengthened the position of Petróleo Brasileiro (Petrobas), the government oil company.

No change in Brazil's oil policy should be expected. The new presidential candidate for the elections this year, General Teixeira Lott, is known to support a tight nationalistic oil policy. And the strong Travalhista party, represented by the present vice president of the Republic, is strictly opposed to foreign capital.

Production up sharply. Brazil's crude oil production from the Bahia fields increased 24.4 percent, from 51,846 barrels per day in 1958 to 64,486 bpd last year. (Table 1.) A total of 562 wells were producing at the end of the year.

Production was averaging about 75,000 barrels per day at the beginning of 1960, and is expected to increase to 100,000 bpd by year end.

The Bahia field was enlarged by new discoveries last year, and its reserves have been increased to an estimated 600 million barrels. But no other oil field has been discovered, despite an extremely active and expensive drilling program.

Drilling remains active. Footage drilled last year totaled 940,372 feet, including nearly 500,000 feet for exploration. (Table 2.)

During the year, 229 wells were completed, of which 92 were for exploration. Of the 92 wildcats, 86 were dry and 6 yielded oil in the Bahia Basin. Of 137 development wells completed in the Bahia area, 122 yielded oil.

Rigs operating at year's end totaled 30, including 17 for exploration.

Thus, while geological and geophysical crew weeks decreased about 4 percent from 1958 (Table 3), exploratory and development activity was up 64 percent and 63 percent.

Middle Amazon: most active area. The most active exploration area in Brazil continues to be the Middle Amazon Basin. Last year, drilling operations extended from the mouth of the Amazon River westward to the Acre Basin within 94 miles of the Peruvian border, a straight-line distance of more than 1,600 miles.

A total of 192,449 feet of exploratory hole was drilled in the Amazon

TABLE 1—Crude Oil Production and Producing Wells in Brazil

FIELD	Producing Zones	Proved Area, Acres, by Zones	*Oil Wells Drilled in 1959	Oil Wells Producing in 1959	Crude Oil Production				
					Barrels in Year		Barrels Daily		Cumulative Bbls. to End 1959
					1959	1958	1959	1958	
Agua Grande	3	75; 1,750; 2,600	42	113	16,158,940	11,871,000	44,271	32,523	35,284,940
Mata	3	400; 500; 1,600		31	610,970	728,000	1,674	1,995	2,249,970
Itaparica	2	150; 250		25	115,715	138,000	317	378	566,715
Paramirim	2	40; 40		2	16,740	12,000	46	33	168,740
Dom Joao	8	40; 1,100	45	230	957,188	949,000	2,622	2,600	4,731,188
Pojuca-Central	3	245; 35; 120		8	1,724		5		20,724
‡Candeias	‡3	1,250; 525; 1,200	13	113	5,570,217	5,215,000	15,261	14,288	19,691,217
Rio da Serra	1	110		12		5,000		14	67,524
Lobato	1	150		4	2,130	1,000	6	3	87,130
Sao Pedro	1	30		1	281		1		281
†Taquipe	1	750	14	15	85,049		233		85,049
†Cassarongongo	1	75	1	1	6,713		18		6,713
†Buracica	1	740; 1,500	7	7	7,920		22		7,920
Others					3,843	4,738	10	13	67,843
Total		14,305	122	562	23,537,430	18,923,738	64,486	51,846	63,035,954

*Excluding gas or gas condensate. †Recent discovery (Reconcavo basin). ‡In Candeias formation.

in the Upper Carboniferous Monte Alagro formation, approximately 18 miles southeast of Manaus. Even though the commercial success of the well has not been established as yet, the discovery represents the initial production obtained from the Carboniferous section anywhere in Brazil.

The sub-commercial Nova Olinda field (1955), some 65 miles to the southeast, produced from rapidly exhausted lenticular sandstone in the Lower Devonian Curuá formation.

In the Paleozoic Piauhi-Maranhão Basin, where sedimentary thickness is rather reduced, one wildcat was reported to have found oil shows. However, drilling activity slowed down to two wells drilling at the end of 1959.

In the Paleozoic Paraná Basin to the south, the thin Iraty shales are oil bearing. However, lava flows of the Serra Geral series, of Triassic to Jurassic age, up to 5,000 feet thick, cover more than 70 percent of the basin. Nine dry holes were drilled during 1959, and 5 rigs were reported drilling at the end of the year.

The most significant oil shows were found in a well drilled near Tangara, Santa Catarina. Heavy oil was found in very fine grained sandstone with little permeability assigned to the Guata group.

Two shallow wells drilled in the Pelotas coastal basin in Rio Grande do Sule indicated a minor sedimentary section existed in the area.

Sergipe-Alagoas Basin. Five rigs penetrated a total of 130,978 feet of section in the states of Alagoas and Sergipe. The oil discovery in Rio Sao Francisco offered additional evidence to sustain an early prediction that the Sergipe-Alagoas Basin is the most prospective area outside of the Reconcavo.

Production has not yet been established and currently a program of acidization of limestone reservoirs at various levels is underway. This represents the first acidization program in Brazil.

Reconcavo-Tucano Basins. Approximately 95,327 feet of exploratory hole were drilled in the petroliferous Reconcavo Basin. The success ratio, including the Taquipe and Cassarongongo wells, which were drilled in 1958 and completed in 1959, was one in slightly more than 5.2.

In addition to the above discoveries, two major oil pools were discovered.

Photo Courtesy PRAKLA

This photograph shows a contract gravity crew working in some dry, remote off-roads country in Brazil. Considerable reconnaissance exploratory work is being done. During 1959, a total of 130 crew-months of gravity work was done in Brazil—of this, 59 party-months was done by contract crews, according to a report compiled by the Society of Exploration Geophysicists which is included in this issue of WORLD OIL as a feature article on pages 96 and 97.

Exploration, particularly geophysical, has been intensified in the last few years in the marginal Cretaceous basins on the Atlantic coast, located in the northern coastal area of the states of Ceará and Rio Grande del Norte, the Sergipe Alagoas coastal belt east of the Bahia graben, and the Espirito Santo coastal area farther south.

Exploration in these areas has been intensified because of the possible Creataceous oil prospects. After striking considerable oil shows in the Sergipe-Alagoas area, drilling has been considerably increased in that region, and 4 rigs were reported operating at the end of the year.

Also, three Brazilian companies have obtained concessions in the Comisión Mixta area in Santa Cruz in Bolivia, of which the southern part was granted to Brazilian private interests according to the agreement with Bolivia in 1958.

Espirito Santo Basin. One rig drilled two stratigraphic tests for a total of 9,521 feet of exploratory section in the basin. The basinward well, near the shore line at Conceicao da Berra, penetrated a Cretaceous section of some 2,844 feet. The lower part of the Cretaceous section in both wells had dead oil shows.

It appears that the land area in this narrow coastal basin has little prospect of finding oil, but that some possibilities might exist in the shallow water of the continental shelf.

TABLE 2—Wells Drilled in Brazil

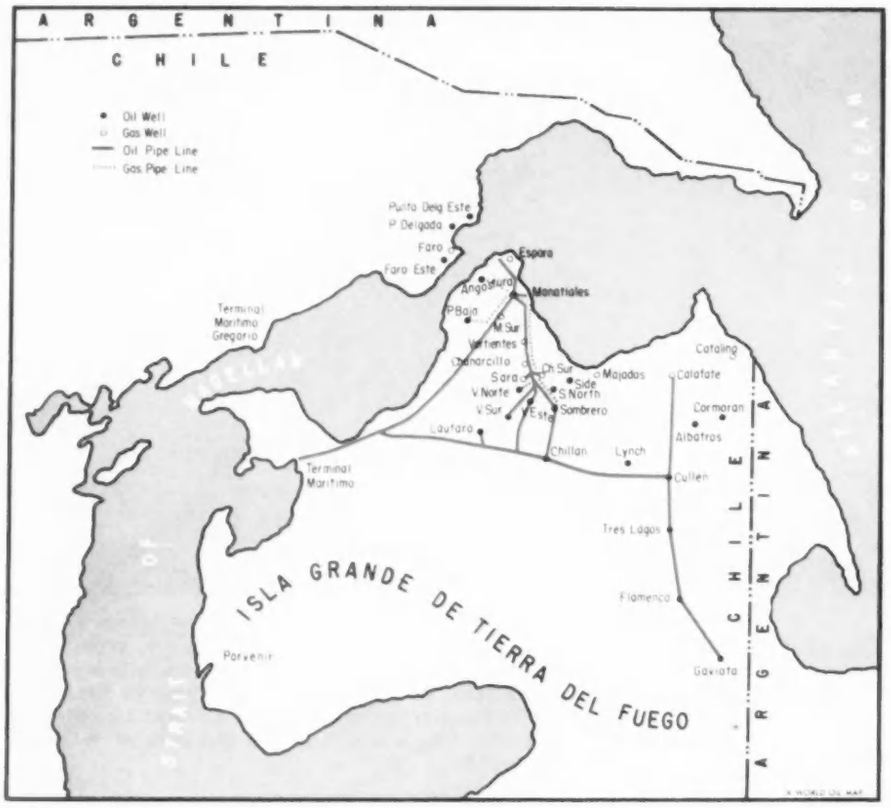
ITEM	Wells Completed					Drilling Year End
	Oil	Gas	Dry	Total	Footage	
1959						
Total Wells	128	.....	101	229	940,372	30
Wildcats	6	.....	86	92	493,034	17
Field Wells	122	.....	15	137	447,338	13
1958						
Total Wells	82	2	56	140	688,698	31
Wildcats	5	1	50	56	427,168	.....
Field Wells	77	1	6	84	261,530	.....
1957						
Total Wells	50	2	38	90	409,215	30
Wildcats	.....	.....	.....	.....	197,165	.....
Field Wells	.....	.....	.....	.....	212,050	.....

TABLE 3—Exploration in Brazil

BASIN	Surveys, Party Months			*Drilling	
	Geologic	Seismic	Gravity	Rig Mos.	Footage
1959					
Amazonas-Maranhao	67	96	95	181	192,449
Sergipe-Alagoas	4	19	.....	67	130,978
Reconcavo-Tucano	48	65	11	91	95,327
Espirito-Santo-Campos	.....	.....	24	6	14,836
Parana	23	.....	.....	60	59,444
1959 Total	142	180	130	405	493,034
1958 Total	153	181	136	390	427,168
% Change	−7	−1	−5	+4	+15

*Exploratory only.

OIL AND GAS DEVELOPMENT IN CHILE



Map shows oil and gas fields and pipe lines of Chile, near the straits of Magellan. There is some production on the mainland, as well as on the island of Tierra del Fuego.

Chile . . . drilling and production increase

THE POLITICAL and economic situation in Chile was further consolidated in 1959 by President Alessandri's new government. The increase in cost of living was for the first time in many years brought to a standstill, and inflation was halted. The exchange rate remained stable, and on January 1, 1960, a new currency was introduced, almost equal in value to the dollar. It is the new "escudo," equal to 96 cents U. S., now the highest currency in South America.

Foreign investments, particularly in the mining industry, increased, and Mobil Oil took a 50 percent share in COPEC, Cia.de Petroleos de Chile, the national distributing company. But oil production remained restricted to the government's monopoly, Empresa Nacional del Petroleo or ENAP.

Oil development by ENAP continued its steady progress. Production increased in 1959 by nearly 16 percent to 1,021,989 cubic meters or 6,428,151 barrels total, against 5,567,883 barrels in the previous year, or 17,611 barrels per day average against 15,254 bpd in 1958. In the early months of 1960, output reached nearly 19,000 bpd.

Capacity of the national refinery at Concon, north of Valparaiso, was doubled by W. M. Kellogg & Co., the original builder, to 44,000 bpd, to equal the domestic demand, which exceeded 42,000 bpd.

The first products pipe line, from Concon refinery to Santiago, the capital of Chile and principal consumer, was completed in 1959. The line is 75 miles long and of 10¾-inch diameter.

Production. Output rose to over 6.4 million barrels, higher than the scheduled 6.3 million barrels. Biggest share of production came, as in the previous year, from the Cullen field. It increased by about 30 percent from 2,052,697 barrels total in 1958 to 2,605,762 barrels in 1959 or from 5,624 to 7,131 bpd. Cumulative output of Cullen field, discovered only in 1954, amounts to 7.3 million barrels.

Sombrero remained the second most important field. Its output was about the same as in the preceding year, totaling 1,042,251 barrels, or 2,856 bpd. Cumulative output of Sombrero field is around 7 million barrels.

TABLE 1—Crude Production, Producing Wells, and Drilling in Chile, by Months

MONTH	Fields Producing	Crude Oil Production During Month		Wells Producing At End of Month			Wells Completed During Month					Rigs Active, End of Mo.
							Wells					
		Total Barrels	Bbls. Daily	Flowing	Artificial Lift	Total	Oil	Gas	Dry	Total	Total Footage	
1960:												
January	31	584,310	18,848	92	8	100	1		3	4	27,606	4
February	31	549,194	18,938	94	8	102	2		1	3	25,192	4
March	31	588,933	18,997	96	8	104	1		1	2	23,602	4
1959:												
January	22	496,266	16,008	97	8	105	3	1	3	7	48,743	5
February	22	458,130	16,362	100	8	108		2	6	8	46,344	5
March	22	515,009	16,613	93	8	101	3		3	6	46,398	5
April		512,266	17,075	94	8	102	2		4	6	36,956	5
May		540,187	17,425	94	8	102	3	1	4	8	60,623	5
June		517,248	17,242	94	8	102	1	1	7	9	49,829	5
July		550,200	17,748	84	8	92			7	7	67,236	5
August		560,723	18,088	89	8	97	2	3	5	10	55,219	5
September		556,056	18,535	92	8	100	2	3	2	7	61,612	5
October		578,083	18,648	92	8	100	3	2	3	8	55,748	5
November		562,862	18,762	96	8	104	3	2	4	9	44,408	5
December		581,121	18,746	92	8	100	4		1	5	47,296	5
1959, Total	31	6,428,151	17,611	92	8	100	26	15	49	90	620,412	5
1958, Total	24	5,567,883	15,254	94	8	102	28	10	36	74	494,134	5
1957, Total	19	4,336,813	11,882	71	6	77	26	10	32	68	487,297	5

The third field in importance is the Victoria pool, of which Victoria South yields the biggest share. Output declined to 678,217 barrels or 1,858 bpd, against 830,353 barrels or 2,275 bpd in 1958. Victoria North and South fields have been producing for 10 years. Cumulative output of Victoria fields is around 5.3 million barrels.

The three fields, Cullen, Sombrero, and Victoria together have yielded about 70 percent of the total output of the Chilean Magellan fields or 19.6 million barrels out of a total cumulative output of around 27.4 million since the first discovery in 1945.

Chillan is one of the newer fields, discovered in 1953. It is southwest of Sombrero field. It declined from 392,715 barrels or 1,076 bpd in 1958 to 271,996 barrels or 745 bpd in 1959. Tres Lagos, southwest of Cullen, discovered in 1957, increased to 424,650 barrels or 1,163 bpd. Gaviota, the most southeastern discovery, near the Argentine boundary, yielded about 71,000 barrels (195 bpd) last year.

Important was the addition of the Punta Delgada discoveries on the continent, north of the Magellan Strait, where Punta Delgada and Punta Delgada East, the latter discovered only in 1958, yielded a total of nearly 150,000 barrels (411 bpd), against only about 2,500 barrels (7 bpd) in 1958.

A directional well from the coast of the continent at Faro was productive. It proved the presence of oil below the sea in the Magellan Strait opposite Manantiales, where oil was first discovered in 1945.

Exploration was continued on the continent. Two inclined wells were drilled below the water of the Magellan Strait. In the Tertiary belt in the foothills east of the Cordillera, the El Salto wildcat was drilled to 7,400 feet. It continued drilling at the end of year, but struck only gas shows in the Tertiary beds. Geological surveys were continued on the Brunswick peninsula, at Ultima Esperanza, and at Rio Payne and Lago Toro, north of Puerto Natales, in the Cordillera region.

In northern Chile, in the province of Tarapaca, seismic and gravimetric surveys were continued; and geological studies were carried out in the Pedernales region, where seepages occur in the Salar de Pedernales.

Drilling. A total of 90 wells was completed in Chile in 1959, against 74 in the previous year; 26 of them yielded oil, 15 gas and 40 were dry. The ratio of dry wells increased slightly above the former average of around 50 percent.

Fifty wells were for development, 21 for extension, and 19 for exploration. Of the exploration wells 17 were dry and 2 yielded oil.

Total number of wells drilled in the Magellan fields, including 1959, amounts to 515, of which 192 yielded oil, 86 gas, and 237 were dry, the proportion of dry wells being 46 percent.

Gas production was around 1.8 million cubic meters or about 64 million cubic feet.

There were 100 wells producing oil at the end of the year, of which 92 were flowing. Average yield was 170 bpd per well.

Five rigs were active, and a total of 189,090 meters or 620,412 feet were drilled, against 494,134 feet in 1958, an increase of 26 percent.

Pipe Lines and Refining. In 1959 nearly 90 miles of new pipe lines were built in the fields.

At the Concon refinery 945,297 cubic meters or 5,945,700 barrels of crude from the Magellan fields, equivalent to 16,290 bpd, were processed, along with 428,398 cubic meters or 2,694,500 barrels of imported crude, equal to 7,382 bpd. The domestic crude represented 69 percent of the 23,672 bpd national crude runs to stills. But the recent doubling of the refining capacity, to 44,000 bpd, will require greatly increased imports.

TABLE 2—Crude Oil Production in Chile, by Fields

FIELD	Total Barrels 1959	Total Barrels 1958	Barrels Daily 1959	Barrels Daily 1958
Manantiales	127,494	54,393	349	149
Sombrero	1,042,251	1,035,684	2,856	2,838
Victoria	678,217	830,353	1,858	2,275
Chanarcillo	295,923	216,604	811	593
Chillan	271,996	392,715	745	1,076
Cullen	2,605,762	2,052,697	7,139	5,624
Vertientes	173,517	157,251	475	431
Flamenco	95,932	110,343	263	302
Tres Lagos	424,650	173,174	1,163	474
Calafata	190,342	188,545	522	517
Others	522,022	356,033	1,430	975
Total Chile	6,428,106	5,567,883	17,611	15,254

Conversion factor: 1 cubic meter = 6.2898 barrels.

TABLE 3—Development and Exploratory Wells Drilled in Chile in 1959

Class	Wells
Total Wells	90
Development	50
Extension	21
Exploratory	19
Oil	17
Dry	2

TABLE 4—Cumulative Number of Wells Drilled in Magellan fields of Chile, Including 1959

Results	Wells
Oil	192
Gas	86
Dry	237
Total	515

Colombia . . . additional companies join in oil exploration and boost drilling; production rises

COLOMBIA'S crude oil output increased in 1959 by 14.2 percent to 53,574,112 barrels or 146,778 barrels daily. Oil development was active, favored by the unstable situation in Venezuela; and several new companies started exploratory drilling.

The political and social situation was stable. The economic situation improved, due to the austerity policy of the government and increasing agricultural and industrial production, while inflation was halted. The official exchange rate rose to 6.40 pesos per dollar for export certificates (in February 1960) from about 6 one year earlier. The difference from the free exchange rate decreased to about 5 percent. The free rate declined to around 6.75 pesos per dollar from about 8 one year previously.

A proposed amendment to the petroleum law has been postponed. Oil companies strongly opposed the proposed new regulations. They would increase the cost of oil development, already high because of the natural conditions of the country, and might make Colombian development unattractive, because of the present oversupply of oil in the world markets.

Production. Crude oil output averaged 146,778 bpd last year and rose further in 1960. Production in January, February, and March 1960 was

above 155,000 bpd. In March it averaged 155,226 bpd.

Largest producer in 1959 was Colombian Petroleum Co. (Mobil-Texas) with 41,687 bpd, a 27 percent increase over 1958. The decline of fields of the Barco concession, in which secondary recovery by water flooding was increased, was more than offset by the high output of the new Cicuco field. Output of Colombian Petroleum Co. rose in March 1960 to 50,041 bpd, and was almost one-third of Colombia's total crude production.

Texas Petroleum Co., principally from its Velasquez and Palagua fields, in 1959 produced 40,320 bpd, 22.5 percent more than in the previous year. But output was declining in 1960, amounting in March to 38,384 bpd.

Shell, in former years the largest producer, recovered an average of 37,322 bpd in 1959, and raised production in January 1960 to about 40,000 bpd. Output in March 1960 amounted to 38,865 bpd, about one-fourth of Colombia's total.

Empresa Colombiana de Petroleos' output from the former De Mares concession declined only slightly to 27,060 bpd in 1959, and rose in 1960 to above 27,000 bpd, averaging in March 27,446 bpd. Forest Oil Corp. of Bradford, Pa., associated with Empresa, carried out secondary recovery by water flooding, with Empresa receiving 62.5 percent of the recovered oil; and drilled 29 wells for water injection, getting a total of 685 bpd. De Mares field's cumulative production exceeds 500 million barrels.

The above four companies provided almost the entire output of Colombia.

PRODUCTIVE AREAS IN COLOMBIA

Approximately 400 wildcats have been drilled in Colombia. They have resulted in the discovery of nearly 50 oil fields.

International Petroleum Co.'s output remained low at 224 bpd in 1959. It has been increased slightly by a discovery at Cachira, which yielded about 120 bpd of very heavy crude. Output in the early months of 1960 averaged around 400 bpd.

Cia. Nueva Granada, subsidiary of United Fruit Co., produced an average of 163 bpd from its Lebrija field, acquired the previous year from Mobil Oil and International. But production declined in 1960, reaching only 92 bpd in March.

At the end of last year, 2,077 wells were producing in Colombia. They yielded an average of 70 bpd per well.

Drilling. In 1959 drilling considerably surpassed that of the previous year. A total of 219 wells was completed against 174 in the previous year. Of them 118 yielded oil, 3 gas, and 98 were dry. Total footage amounted to 1,205,382 feet, against 948,231 in the previous year, an increase of 27.3 percent.

Twenty-two rigs were operating at the end of the year, 10 for exploration and 12 for development. At begining of April 1960, 12 rigs were active for exploration and 11 for field development.

Deepest well drilled so far in Colombia was Empresa's exploration

TABLE I—Crude Oil Production, Producing Wells, and Drilling in Colombia in 1959 and 1958

Company and Field	Crude Oil Production: Barrels in Year 1959	Barrels in Year 1958	Barrels Daily 1959	Barrels Daily 1958	Barrels Cumulative Through 1959	Producing Wells at End 1959	Wells Completed 1959	Wells Completed 1958	Footage Drilled 1959	Footage Drilled 1958	Wells Drilling End 1959
Shell Condor S. A.	**13,622,494**	**12,764,284**	**37,322**	**34,971**	**167,550,550**	.....	**21**	**18**	**149,208**	**139,001**	**1**
Casabe (Yondo)	8,279,810	9,412,556	22,684	25,788	141,614,657	.....	...	...	.....	.....	...
Cantagallo	912,803	828,934	2,501	2,271	7,838,318	.....	...	...	.....	.....	...
San Pablo	4,091,155	2,165,468	11,209	5,933	10,477,275	.....	...	...	.....	.....	...
Difficil	338,726	357,326	928	979	7,620,300	.....	...	...	.....	.....	...
Empresa Colombiana de Petroleos: De Mares	**9,876,888**	**10,049,607**	**27,060**	**27,533**	**506,394,325**	.....	**44**	**27**	**172,215**	**108,646**	**2**
Colombian Petroleum Co. (Mobil-Texas)	**15,215,894**	**11,985,659**	**41,687**	**32,837**	**159,937,798**	.....	**33**	**40**	**179,020**	**218,494**	**3**
Barco	9,103,045	9,434,927	24,940	25,849	150,762,372	.....	...	...	.....	.....	...
Cicuco	6,109,504	2,550,732	16,738	6,988	9,172,081	.....	...	...	.....	.....	...
Violo	3,345	...	9	...	3,345	.....	...	...	.....	.....	...
Texas Petroleum Co.	**14,716,601**	**12,015,448**	**40,320**	**32,920**	**55,870,288**	.....	**66**	**64**	**351,776**	**303,590**	**7**
Velasquez	10,430,513	8,389,250	28,577	22,984	44,113,262	.....	...	...	.....	.....	...
Palagua	3,569,410	2,957,837	9,779	8,104	8,575,418	.....	...	...	.....	.....	...
Tetuan	462,253	420,079	1,266	1,151	2,612,117	.....	...	...	.....	.....	...
Ermitano	203,215	186,384	557	511	443,299	.....	...	...	.....	.....	...
Sogasmoso	49,493	61,898	136	170	124,475	.....	...	...	.....	.....	...
Baul	1,717	...	5	...	1,717	.....	...	...	.....	.....	...
International Petroleum Co.	**81,969**	**79,807**	**224**	**219**	**811,419**	.....	**10**	**10**	**60,046**	**73,302**	**2**
Totumal	40,152	42,994	110	118	326,054	.....	...	...	.....	.....	...
Aguachica	22,477	26,914	62	74	440,925	.....	...	...	.....	.....	...
Others	19,340	9,899	52	27	44,440	.....	...	...	.....	.....	...
Compania Petrolera Nueva Granada (United Fruit): Lebrija	**59,493**	**4,322**	**163**	**12**	**63,815**	.....	**5**	...	**51,214**	...	...
Amkirk Petroleum Corp. Floresanto	**773**	**592**	**2**	**2**	**1,365**	.....	**1**	**1**	.....	**4,828**	...
Cities Service Colombia	...	...	...	...	...	.....	**7**	**2**	**59,814**	**22,042**	...
Richmond Oil Co. (Standard of Calif.)	...	...	...	...	...	.....	**2**	**2**	**19,689**	**13,757**	...
Colombian Sun Oil Co.	...	...	...	...	...	.....	**1**	**2**	**10,569**	**23,814**	...
Forest Colombian Corp.	...	...	...	...	...	.....	***29**	***6**	**142,505**	***24,570**	...
Mobil Oil Co. de Colombia	...	...	...	...	...	.....	...	**2**	.....	**16,187**	...
John W. Mecom	...	...	...	...	...	.....	...	...	**9,326**	.....	**1**
Undistributed	...	...	...	...	...	.....	...	...	.....	.....	**6**
Total, Colombia	**53,574,112**	**46,899,719**	**146,778**	**128,494**	**890,629,560**	**2,077**	**219**	**174**	**1,205,382**	**948,231**	**22**

* Water injection wells.

well Lizama 4, of 15,556 feet total depth, abandoned in the Cretaceous, but reportedly having struck a pay farther above.

Exploration was intensive in 1959. Fourteen operators were active, including the four principal producers; International; Mobil Oil and Richmond, which have been operating a long time in Colombia; the Colombian Cities Service Co. on the 2 million acre Cararé lease of Empresa's De Mares concession; Forest Oil of Pennsylvania, for secondary recovery of Empresa's fields; John W. Mecom of Houston, under a 75-25 agreement with Empresa for the new Tolu concessions on the Caribbean coast; Sun Oil of Colombia; Sinclair Colombian Oil Co.; Neuva Granada of United Fruit Co., and Amkirk Petroleum Co.

Cities Service continued drilling at Aguas Claras, where well No. 1 had yielded about 400 bpd of heavy crude. No. 5 was dry at 8,547 feet.

Wildcats. In Colombia 36 wildcats were drilled last year, of which 5 struck oil, 1 gas and 30 were dry.

Sun Oil drilled 3 dry wildcats, 2 in the Sinu basin and 1 on the Gulf of Uraba, the most western part of Colombia's Caribbean coast.

Sinclair Oil drilled two dry wildcats in the Magdalena basin. Amkirk drilled unsuccessfully, on the Caribbean coast between Barranquilla and Puerto Colombia, a wildcat at Campito 4,125 feet deep.

John W. Mecom completed Tolu 1 well in the Caribbean coastal area as a gas producer of reportedly 2 million cubic feet dry gas daily, and the second well is reported to promise a still higher output. Mecom proposes to start commercial production of gas. The well in Chinu remained dry.

Nueva Granada Co. continued drilling in its Lebrija field in the middle Magdalena, but output remained small.

Drilling activity has been extended for the first time to the vast Llanos region, east of the Andes. Mobil Oil Co. jointly with Shell drilled a wildcat at La Heliera in the northern Llanos, south of Venezuela's Barinas basin and 600 miles distant from the sea. It was abandoned at 8,961 feet on the Paleozoic basement. Total cost is reported as exceeding $3 million.

TABLE 2—Results of Drilling in Colombia in 1959

Kind of Wells	Wells Completed in 1959			
	Oil	Gas	Dry	Total
Wildcats	5	1	30	36
Development Wells	113	2	68	183
Total	118	3	98	219

Texas Petroleum Co. spudded a wildcat at Guavio, 65 miles east of Bogotá in the Llanos foothills, transporting rig and material by airlift. The well was drilling in April 1960 below 10,000 feet.

Results of the vast drilling campaign have been moderate. Principal discovery was Shell's Cristalina 3 well, with a yield of around 900 bpd, and Mecom's gas well at Tolu. Two exploration wells of Texas, drilled to the basement, gave a small yield. International's one discovery has been mentioned above.

Cicuco. The only really important discovery of recent years has remained the Cicuco field in the lower Magdalena region, found in 1956, where output exceeds 20,000 bpd. A gas line from Cicuco to Barranquilla, about 140 miles long, will be constructed at a cost of $6 million by Colombian Petroleum Co. jointly with national interests.

Colombia has remained one of the most actively developed oil countries of South America, favored by its geographical position on the Caribbean, attractive legislation, and stable policies; and its output is increasing steadily.

However, the producing area has remained circumscribed to the Magdalena and the Maracaibo basin. In the large Pacific coastal area, the proper Caribbean coast, and the vast Llanos region to the east of the Andes Mountains, drilling has not yet proved commercial oil.

Domestic oil consumption in Colombia amounted to 50,216 bpd in 1959, about one-third of the production. Exports amounted to around $73 million or 28.5 million million barrels.

Ecuador . . . more drilling scheduled in 1960, following curtailment in 1959; production declines

Oil production in Ecuador has continuously declined in recent years from a high of nearly 10,000 barrels per day to 7,734 bpd in 1959. The economic situation of the country has improved steadily in the past few years, because of rapidly increasing agricultural exports. Ecuador is the largest banana exporter of the world. The political situation and exchange rate have been stable.

Oil development, as in Peru, has been hampered by the unprofitable domestic ceiling prices imposed by the government. Finally, in July 1959, the government increased the domestic prices to about 15 cents per gallon for ordinary gasoline and in different scales for other products. The halted construction of the 7,700 bpd refinery of Anglo-Ecuadorian Oilfields at La Libertad was therefore renewed and completed at the end of the year. However, the government again lowered gasoline prices on April 22, 1960.

Development. Oil prospects in the large Tertiary coastal belt are attractive. But no important discovery has been made for many years. Exploration of Ecuador's Oriente, east of the Andes Mountains, by Shell and Standard (N. J.), carried out under most difficult natural conditions and expenditure of $40 million, has remained unsuccessful.

In the coastal area the only producers have remained Anglo-Ecuadorian Oilfields Ltd., subsidiary of Lobitos Oilfields of London, which operates also some small local producers, and Tennessee del Ecuador, subsidiary of Tennessee Gas Transmission Co., which had acquired in 1958 the holdings of Manabi Exploration Co. Standard Oil (N. J.) acquired a share in Anglo-Ecuadorian, formerly held by South American Gold & Platinum Co., and became, in association with Lobitos Oilfields, similar to the association in Peru, the majority shareholder of the company.

California Ecuador Petroleum Co., subsidiary of Standard of California, holds around 2.75 million acres of

ECUADOR

concessions, and was reported to propose offshore drilling in the Gulf of Guyaquil. Besides, a number of national and foreign smaller independents have covered most of the coastal area and Guayas province.

Ecuador's domestic consumption amounts to about 8,500 bpd and requires therefore a considerable import of products.

Production. Ecuador's crude output decreased in 1959 by 782 barrels to 7,734 bpd. Anglo-Ecuadorian in its fields in Santa Elena slightly raised its production from 6,600 to 6,828 bpd in 1959. The production came from 1,393 producing wells at the end of the year, of which 31 were flowing and 1,362 gas lift and pumping. Average yield per well was scarcely 5 bpd. Average depth was 4,500-5,000 feet. Principal producer remained the Ancon field, which also yields gas.

For Tennessee Gas, which operates the concessions of the former Manabi Exploration Co., output dropped sharply from 1,916 bpd in 1958 to only 906 bpd last year. At the end of the year there were 198 producing wells, of which 24 were flowing. Principal producer has remained the Tigre field, around 4,500 feet deep. Small production comes from some shallow fields of about 1,500 feet depth.

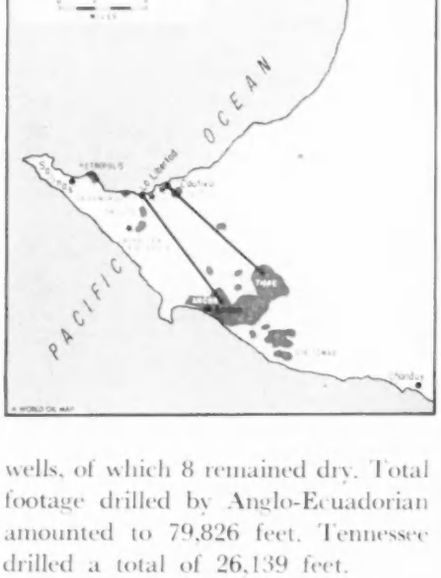
Wells producing in Ecuador at the end of 1959 totaled 1,591 against 1,548 one year previously.

Drilling decreased from 42 completions in 1958 to 29 last year. Anglo-Ecuadorian drilled 19 wells, which all yielded oil. Tennessee completed 10 wells, of which 8 remained dry. Total footage drilled by Anglo-Ecuadorian amounted to 79,826 feet. Tennessee drilled a total of 26,139 feet.

For the year 1960 Anglo-Ecuadorian has projected 36 new wells, and Tennessee 5 wildcats.

OIL FIELDS OF ECUADOR AND PERU

OIL FIELDS OF SANTA ELENA PENINSULA, ECUADOR



Crude Oil Production and Drilling in Ecuador in 1959 and 1958, by Companies

COMPANY*	Crude Oil Production		Wells Producing, Yr. End			Wells Completed During Year					Wells Drilling Year End
	Total Bbls.	Bbls. Daily	Flowing	Art. Lift	Total	Oil	Gas	Dry	Total	Footage	
1959											
Anglo-Ec.	2,492,220	6,828	31	1,362	1,393	19			19	79,826	3
Tenn. Ec.	330,735	906	24	174	198	2		8	10	26,139	2
Total	2,822,955	7,734	55	1,536	1,591	21		8	29	105,965	5
1958											
Anglo-Ec.	2,409,177	6,600	...	...	...	39		2	41	103,311	2
Man. Ex.	699,320	1,916									
Others	...	...				...	...	1	1	13,594	...
Total	3,108,497	8,516	87	1,461	1,548	39	...	3	42	116,905	2

* Company names are abbreviated as follows: Anglo-Ec., Anglo-Ecuadorian Oilfields Ltd.; Tenn. Ec., Tennessee del Ecuador S. A. (which in 1958 acquired properties of Manabi Exploration Co.; Man. Ex., Manabi Exploration Co.

Guianas . . . aerial surveys made in 1959

LITTLE ACTIVITY was reported in the Guianas in 1959 and 1960.

British Guiana. California Oil Co. (British Guiana) Ltd. did no active work on its 16,000 square-mile license covering offshore waters and the contiguous coastal strip of British Guiana. This license expired on April 15, 1960.

Dutch Guiana. Farther east in Surinam (Dutch Guiana) Aero Service Corp. and Canadian Aero Service announced a 66,000 line-mile aerial magnetometer survey in mid-1959.

Paraguay . . . oil search discontinued

INTEREST IN OIL prospects of Paraguay, particularly in the Chaco region on the Bolivian border, became lively, when foreign development started in neighboring Bolivia. Pure Oil Co. of Paraguay, associated with several other American companies, conducted exploration and drilling on a 14-million-acre concession; and 4 wildcats were completed (1 in 1958 and 3 in 1959), overcoming the big difficulties of access and supply in a wild region, inhabitated only by Indians.

The last wildcat, Mendoza 1, drilled to 10,000 feet, remained dry, but at a higher level (1900 feet) struck gas, non-commercial because of the geographical situation. Pure Oil has suspended operations, but retains a smaller acreage of about 3 million acres.

Pure's associates were Williams Brothers Co., Gulf Oil Corp., Sinclair Oil Corp., and Tidewater Oil Co. Madrejon 1 was abandoned in 1958 at 5,668 feet. Lagerenza 1, 85 miles northwest of Madrejon 1, was abandoned January 24, 1959, at 9,488 feet. Carlos Lopez 1 was abandoned about April 10, 1959, at 5,679 feet.

Brazillian interests also reportedly obtained a concession, but no activity has been reported.

In Paraguay the economic situation has improved steadily.

Peru . . . development has revived, following government's lifting of ceiling prices on oil products

PERU'S OIL development was seriously handicapped during the first half of 1959 by the complete suspension of drilling by International Petroleum Co. and Compañia Petrolera Lobitos. Those companies produce about 90 percent of the country's output. Their inactivity was due to the continued imposition of extremely low ceiling prices for the domestic market, which consumes about 80 percent of the total output.

Oil development was resumed only after the change of the cabinet. The new Prime Minister took severe measures for halting the rapidly growing inflation, balancing the budget, and improving the economy of the country.

By government decree of July 25, 1959, domestic prices of oil products were raised considerably. The decree nearly doubled the prices of ordinary 66-67 octane gasoline to about 15 cents U. S. at the filling station, and tripled those for some other products. The increases provided a satisfactory balance for the producer.

At the same time the government announced its proposal to submit a new law to congress for adjusting the concessions of International and Lobitos Co. to the petroleum law 11780 of 1952. It establishes the international market price for crude oil. This law is valid for the companies which entered the country after enactment of this law.

International shortly afterwards improved the grade of its widely used premium gasoline, sold at around 19 cents per gallon to over 80 octane. In March 1960, because of the new stabilization of the Peruvian currency and economy and the resulting lower operating costs, International reduced the price of the higher octane gasoline by about 5 percent and cut, in larger proportion, the prices of industrial kerosine, diesel, and residual fuels.

However, attacks of one of the principal newspapers continued against International Petroleum Co. Oil became again a political football of the opposing parties.

International renewed drilling in August 1959, employing 6 rigs. However, because of the long recession, crude production for the year declined by 5.4 percent from 51,320 barrels daily in 1958 to 48,564 bpd in 1959.

Development. Favorable new developments included: Activated drilling in deeper waters on the continental shelf by Peruvian Pacific Petroleum Co., subsidiary of Cities Service and Richfield Oil Corp.; successful drilling on the northern coastal field by Petrolera Amotape, subsidiary of Amotape Oil Inc.; start of drilling by Belco Petroleum Corp. of New York, which had acquired the holdings of Petrolera Peruana; and in the Amazon basin of eastern Peru the beginning of commercial production from the Maquia field, discovered in 1957, and locating of a first well by Cerro de Pasco Petroleum Corp., to be spudded in September 1960.

Peruvian Pacific Petroleum Co. widely enlarged its holdings on the continental shelf by leasing from Empresa Petrolera Fiscal about 677,000 acres (274,100 hectares) of new offshore concessions. They extend on the shelf from Cabo Blanco to a line 50 kilometers (31 miles) distant from the Ecuadorian frontier. The 50 kilometer frontier belt, by Peruvian law, is closed to foreign companies.

In exchange Peruvian Pacific returned to Empresa Fiscal its entire concessions on the mainland, located east, to the interior, of Lobitos concessions, and south and north of Zorritos. In the area east of Lobitos, Peruvian Pacific had drilled in former years 13 wells, of which only two struck oil in the Mogollon Conglomerate, the shoreline facies of the lower Eocene Salinas formation. Those wells, which yielded at the end of the year around 70 bpd together, were transferred to Empresa Fiscal at a price of $130,000, to be discounted from the surface rentals of the new offshore concessions.

Offshore. Peruvian Pacific Petroleum Co. (Cities Service) in 1959 with its 600-ton drilling boat "Rincon," brought from California, completed five wells in deeper waters offshore from Lobitos and Cabo Blanco, south of the new concession area. The first well, drilled offshore from Lobitos to 5,662 feet, found only gas shows. The second, 3,560 feet deep, yielded 416 bpd from Lower Eocene Parinas sands. A third, about 2½ miles farther north, yielded around 200 bpd. A fourth, offshore from Cabo Blanco, produced 360 bpd at 920 feet and around 200 bpd additional from about 1,400 feet. The fifth well, drilled offshore from Lobitos to 6,363 feet, remained dry.

Some completions were made on the bottom of the ocean. After repairing the Rincon boat, Peruvian Pacific proposes to continue drilling in its new concessions farther north, and started in April 1960.

Almost the entire Peruvian shelf from the mouth of the Chira river to Ecuadorian frontier belt is now covered by concessions. Peruvian Pacific Petroleum Co., under different agreements with Petrolera del Pacifico, Petroleo Sullana, and Empresa Fiscal, holds a total of 322,697 hectares or around 800,000 acres. Belco Petro-

Oil Fields of Peru and Ecuador

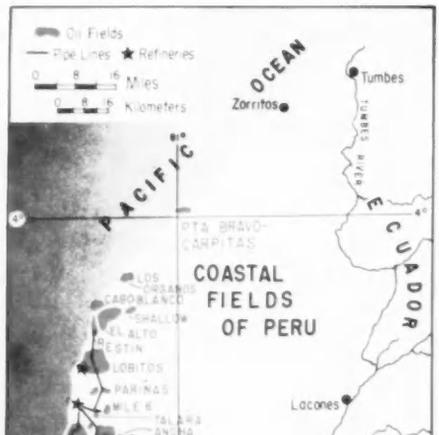
leum Corp. holds 8,992 hectares or around 22,400 acres offshore concessions, called Litoral, from the former Petrolera Peruana. Belco Petroleum already has drilled two inclined offshore wells from the coast south of Negritos to depths of 5,419 and 5,351 feet. Both struck oil. Well 3-1 yielded an initial output of 175 bpd. A third well had been spudded in April 1960.

Onshore. On the contrary, the concession area on the mainland on the northern coast has been reduced. Exceptions include: International's Brea-Pariñas field; Cia. Petrolera Lobitos, operating under older legal provisions, on the lease of Petrolera Amotape of 20,221 hectares or around 50,000 acres, adjoining Lobitos area to the north; and Belco Petroleum's Mirador concession, formerly of Petrolera Peruana, of 4,034 hectares or around 10,000 acres, adjoining to the south International's Brea-Pariñas field, both operating under the new petroleum law of 1952. Besides, on the northern bank of the Chira river, two small concessions, totaling some 5,000 acres, are still held for legal reasons by Peruvian Pacific and Transwestern Co., the entire Sechura desert area having been relinquished.

The big concession area of 870,000 hectares or more than 2 million acres of Empresa Fiscal, with exception of Organos field, the depleted Zorritos, and the Peru section in the south, covers in great part sterile rocks of Paleozoic age.

Production. Crude production of Peru in 1959 amounted to 17,725,847 barrels or 48,564 barrels per day, against 51,320 bpd in 1958, a decline of 5.4 percent. However, due to renewed drilling, output increased in the later months of the year. It amounted in January 1960 to about 51,700 bpd plus 2,735 bpd of condensate.

Output of Brea-Pariñas field of International Petroleum Co. declined in 1959 by about 9 percent to 8,223,956 barrels or 22,531 bpd. Production of natural gasoline amounted to an additional 772,643 barrels (2,117 bpd). Output of the Lobitos fields, operated also by International, declined also, because of the long suspension of drilling, to 7,535,040 barrels or 20,644 bpd, against 21,569 bpd in 1958. Additionally, condensate production was



218,606 barrels or 599 bpd in 1959, slightly higher than in 1958.

However, after renewed drilling, the yield of Lobitos fields rose nearly 10 percent to 22,630 bpd in January 1960 and was approaching Brea Pariñas output of 23,394 bpd at the same date. While Brea-Pariñas field continues declining and secondary recovery plays an important role, Lobitos fields still enclose considerable reserves to be developed.

Empresa Petrolera Fiscal's production rose slightly to 928,516 barrels or 2,544 bpd for the year 1959, and continued rising in 1960, reaching in January 1960 a level of 2,913 bpd. Headquarters were completely moved from the depleted Zorritos field to Organos, and a new town there was built. The deficit budget of former years was cancelled, and at the beginning of 1960 Empresa reportedly showed a favorable balance of 18 million soles or about $600,000.

Output of Petrolera Peruana's Mirador field, which was acquired by Belco Petroleum, declined in 1959, because of complete cessation of drilling, dropping around 30 percent to 78,870 barrels or 216 bpd. But by starting new drilling and development, Belco Petroleum raised its total output to about 750-800 bpd in May 1960, from 13 producing wells.

Petrolera Amotape, subsidiary of Amotape Oil Inc., increased its output substantially from 22,705 barrels in 1958 to 72,480 barrels in 1959 or 199 bpd. This was accomplished by further drilling of shallow wells of about 2,000-foot depth to the Upper Eocene Verdun sands. The lower Eocene sands offer important prospects to be developed in greater depth.

Peruvian Pacific Petroleum Co's. output declined about one half to 27,769 barrels total or 76 bpd, due to the natural decline of its only two wells. The company transferred both wells to Empresa and concentrated its activity on the shelf.

In the Amazon basin Ganso Azul Co. produced 804,175 barrels or 2,203 bpd in 1959 against 1,951 bpd in the previous year, an increase of nearly 13 percent. About 2,000 bpd are shipped to the Manaos refinery in Brazil and the balance to the national refinery of Empresa Fiscal in Iquitos for local consumption.

In the late months of 1959 the Maquia field of El Oriente Co. and its German associates, discovered in 1957, started production with about 20,000 barrels monthly or around 700 bpd. The company acquired two barges of 8,000 barrels each for transport of the crude. Its 10 wells, of which 9 are flowing and one pumping, are producing in turns. However, later on, because of delivery difficulties in Brazil, output was reduced to about 16,000 barrels monthly or some 500 bpd, the potential output being around 1500 bpd. The crude is shipped to Manaos refiinery in Brazil and to Iquitos.

Drilling activity and completions of wells dropped sharply in 1959. International Petroleum, because of suspension for 7 months, completed only 14 wells in Brea-Pariñas, of which 12 were producers and 2 dry; and 16 wells in Lobitos, of which 15 yielded oil.

Total number of completions in Peru dropped in 1959 to 65, of which 9 remained dry, against a total of 138 in 1958. Footage declined about one-half from 543, 741 feet in 1958 to 284,200 in 1959.

Empresa Petrolera Fiscal completed 21 wells, of which 19 yielded oil and 2 remained dry. One of the wells was semi-exploratory, the others development wells. Three rigs are active.

Belco Petroleum Corp. started drilling in November 1959 with two rigs of South America Drilling Co.,

shipped from Venezuela. Up to April 1960 two wells were drilled in Mirador field to the Paleozoic basement at 6,275 and 6,096 feet. The first yielded 210 bpd in the test from the Cretaceous, leaving the higher Eocene sands to be opened later. The second was being tested. A third well was being completed at 5,948 feet. Besides, two producing offshore wells were completed, as mentioned above.

Petrolera Amotape in 1959 drilled 8 wells, of which 6 yielded oil. In April 1960, the total number of wells amounted to 17, of which 11 struck oil, 2 gas, and 4 remained dry.

Richmond Oil Co., after relinquishing all its Sechura concessions, withdrew from operation, retaining only about 500,000 acres of concessions in the Amazon basin.

Amazon Basin. The German syndicate of Deutsche Erdöel, Elwerath and Wintershall, associated with El Oriente Co., in January 1959 had completed its last well, No. 10, in Maquia. In the early months of 1960 it closed an agreement with Mobil Oil Co. for drilling a wildcat on a 50-50 share in its Aguaytia concession, near the mouth of the San Alejandro river, in the middle Ucayali basin west of Pucallpa. This well will be the first of Mobil Oil in Peru.

Cerro de Pasco Petroleum Corp., which had actively carried out surface and seismic exploration in the southern Ucayali basin, has located its first well on the Iscozazin structure, to be spudded in September of this year.

Texas Petroleum Co. withdrew completely, shipping its rig to the Putumayo river in Colombia, but retains about 2 million acres in the Amazon basin.

Other companies, including Peruvian Gulf, International, and Peruvian Pacific, continued surface exploration, but have not yet announced any drilling program.

Venezuela . . . Conservation is stressed as drilling declines. Crude oil production remains high

INCREASING governmental intervention and participation in oil industry matters were highly apparent in 1959 and 1960 in Venezuela. A national oil company, authorized to engage in all operational phases of the industry was chartered in April 1960. The government was pushing for more complete utilization and conservation of natural gas, and has caused some high gas-oil ratio wells to be shut in, both in western and eastern Venezuela. There were other government efforts to promote confidence in private investment in Venezuela, but the nation has become a narrow profit margin area for oil and other industries because of high taxes and other factors.

The oil industry continues to cooperate with the government, and late in 1959 several companies made advance payments on 1960 taxes in order to alleviate the government's short-term fiscal problems. However, with all pertinent factors, including the general worldwide oversupply of crude and the government's ban on any new future concessions tending to discourage exploration, the oil search in Venezuela was being curtailed.

Drilling was fairly active in the most prolific proven trends. Mene Grande Oil Co. and Venezuelan Sun Oil Co. continued to make very important new oil discoveries and extensions in Lake Maracaibo. In far western Zulia state, near the Colombian border, Colon Oil Company, Ltd., made an interesting deep oil discovery in Cretaceous beds. In eastern Venezuela, Mene Grande announced an important oil find in Anzoategui. Offshore in the Gulf of Paria, successful extension of the new Posa offshore field continued, and either a new discovery south of it or a one-mile southward extension was reported in 1960. It appeared that Posa would be equivalent in size to the Soldado offshore field across the border in Trinidad.

Crude oil reserves continued to rise last year owing to important results from development drilling, curtailed though it was. Almost record withdrawal of crude oil occurred in 1959, with production exceeding a *billion* barrels for the second time in history, almost equalling the 1957 output stimulated by the Suez crisis. Crude oil production during the first half of 1960 declined slightly compared to the same period in 1959.

The government evidently plans to push conservation of known reserves of oil and gas, and forego for the present any huge additions to reserves, since normal development and extension drilling is apt to maintain satisfactory reserves in the near future. With more than 5,000 oil wells shut in at the end of 1959, it appeared that the government's policies as to reserves are not a dangerous gamble for the time being.

Concessions. The area covered by concessions on December 31, 1959, was 5,754,242 hectares (14,218,732 acres), compared with 15,695,090 acres a year earlier. Hence, the reduction of 1,476,358 acres during 1959, represented a 9.4 percent decline in holdings. The surface area covered by concessions at the end of December represented 6.3 percent of the national area and 14.4 percent of the portion with oil possibilities, estimated at about 40 million hectares or almost

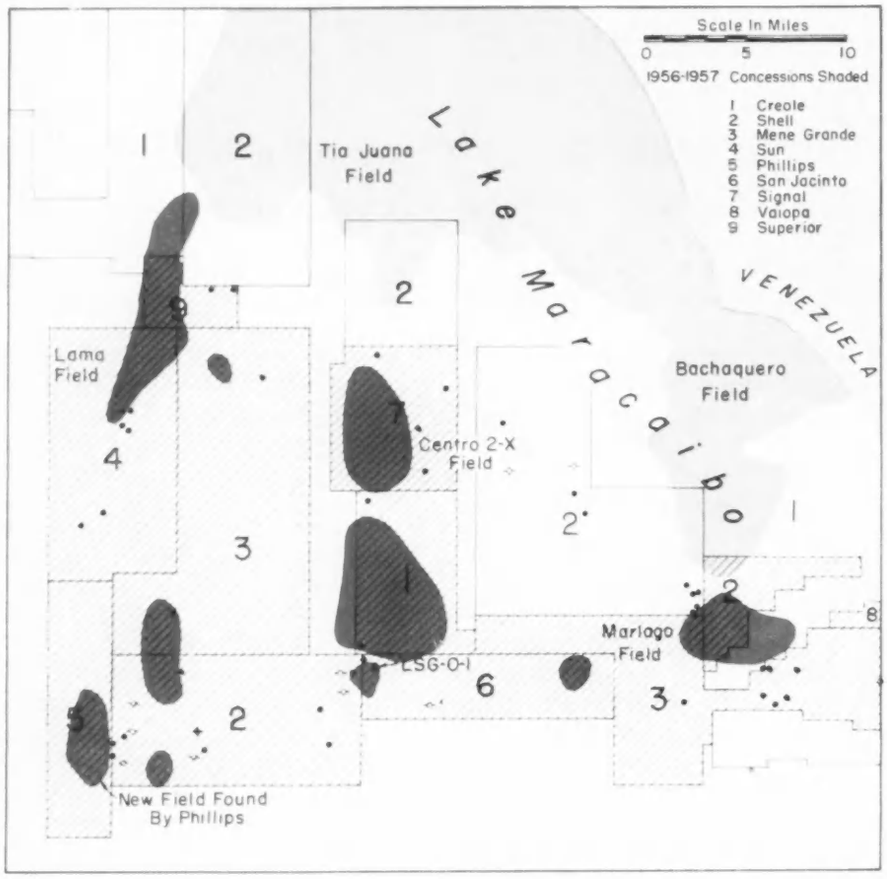
Crude Oil and Condensate Production, Producing Oil Wells, and Drilling in Peru in 1959

COMPANY	Production 1959 Total Bbls.	Production 1959 Bbls. Daily	Production 1958 Bbls. Daily	Oil Wells Producing At End of 1959 Flowing	Oil Wells Producing At End of 1959 Artificial Lift	Oil Wells Producing At End of 1959 Total	Wells Completed In 1959* Oil	Wells Completed In 1959* Dry	Wells Completed In 1959* Total	Wells Drilling End of Year
International Pet. Co.										
Brea-Parinas, Crude	8,223,956	22,531	24,792	168	1,595	1,763	12	2	14	6
Condensate	772,643	2,117	1,983							
Lobitos fields, Crude	7,535,040	20,644	21,569	92	833	925	15	1	16	
Condensate	218,606	599	563							
Empresa Petrolera Fiscal	928,516	2,544	2,498	34	135	169	19	2	21	3
Ganso Azul Co.	804,175	2,203	1,951	3	11	14				
Belco Pet. Corp., Mirador field	78,870	216	313	3	8	11				2
Peruvian Pacific Pet. Co. (Cities Service)	27,769	76	†		2	2	3	2	5	
Petrolera Amotape	72,480	199	62	3	7	10	6	2	8	
Douglas Oil Co. of Calif.			30							
El Oriente Co., Maquia field	55,041	151	†	9	1	10				
Grouped Data			102				1		1	
Total, Crude	17,725,847	48,564	51,320	312	2,592	2,904	56	9	65	11
Total, Condensate	991,249	2,716	2,546							

1. In addition there was condensate production of 723,738 barrels total or 1,983 barrels daily.
2. In addition there was condensate production of 205,653 barrels total or 563 barrels daily.
3. In addition there was condensate production of 929,391 barrels total or 2,546 barrels daily.

*Total footage, 284,200 feet; average depth, 4,372 feet per well. †Included below in Grouped Data.

NEW DISCOVERIES IN LAKE MARACAIBO



100 million acres. About 40 percent of the concession areas at the end of 1959 were in the western states of Zulia, Falcon, Barinas, Trujillo, Mérida, Tachira and Apure. The remaining 60 percent was in the central and eastern states of Aragua, Guárico, Anzoategui, Monagas, Sucre and the Federal territory of Delta Amacuro.

Of the total end-of-1959 concession area, 5,553,213 hectares (13,672,569 acres) consisted of exploitation concessions, and the remaining 546,163 acres were in exploration concessions. The proportion of exploration concessions declined from 5.4 percent at the end of 1958 to 3.8 percent a year later.

Exploration. The most important exploration development during the past year was revealed by Gulf Oil Corp. in April 1960. In the south Ceuta area of Lake Maracaibo on concessions obtained during 1956, Mene Grande Oil Co. completed three widely-spaced wells as highly prolific oil producers. With individual pay thicknesses of each well totaling up to 1,000 feet, officials felt that this could be the largest field found by Gulf companies since the original Kuwait discovery. Based on geophysical data coordinated with the well logs, it appeared that the entire field would fall on Mene Grande acreage.

Mene Grande's northern Anzoategui (eastern Venezuela) find is on La Ceiba structure where two wells were completed as excellent producers. Each has pay sands about 700 feet thick.

Paria Operations, Inc., a combine composed of Continental Oil Company, Texaco Inc., interests, The Ohio Oil Company, Richfield and Cities Service reported encouraging shows in Block 117-1, located a mile south of established Posa field production. Three oil wells had been completed by March 1960. Production is from the Cruse sand of Miocene age at depths between 4,000 and 4,300 feet. The discovery well, completed in 1958, tested 600 bpd in one zone and about 1,100 bpd in a second. The second successful test in Posa field was completed flowing 330 bpd of 14.5° API gravity oil. The third well flowed 1,014 bpd from about 250 feet of oil sand. A fourth well found more than 160 feet of oil sand and was expected to be a producer also. All wells following the discovery were being drilled directionally from a platform designed to drill up to 25 wells.

In the south Posa extension or new discovery (Block 117-1), logs indicate that 80 feet of oil sands were penetrated at depths between 5,480 and 6,420 feet.

In the remote Colon district of southwest Zulia, Colon Oil Co., Ltd., continued drilling deep Cretaceous wells. In Rosario, CR 5 bottomed at 15,491 feet, and casing was cemented at 15,232 feet. Production tests yielded 41° API gravity crude from several pays in the Tibu limestone. In December 1959, Colon's business and properties were sold to Compañía Shell de Venezuela Ltd. (CSV), and Colon was dissolved. Colon's activities had been included in CSV's listing for statistical purposes for some time.

Geophysical activity was being cut back throughout the year, but significant coverage was acquired nevertheless. The following crew-months were tabulated for 1959: Seismograph, 66.3; gravity, 25; surface geology, 81.4; and structure drill, 48.4. Areas surveyed were computed as follows: By seismograph, 2,610,073 acres; by gravity, 1,948,038 acres; by surface geology, 13,331,169 acres; by surface photogeology, 622,692 acres; by structure drill, 18,582 acres; by aerial photogeology, 15,984,899 acres; areophotogrammetric survey, 5,655,131 acres, and by topographic survey, 211,666 acres.

Drilling, development, and other exploration. A total of 707 wells were completed in 1959, including 552 oil wells, 8 gas wells, 137 dry holes, 1 air injection and 9 gas injection wells. Forty wells, in addition, were suspended at the end of 1959. 1959 drilling operations are summarized by companies and districts in Table 2. The 707 completions represent a steep 40.8 percent decline from the 1,195 completions in 1958. There were 1,746 in 1957. The decline was continuing in 1960.

There were 61 wells being drilled at the end of 1959, including 26 in Maracaibo district, 27 in Barcelona district, 6 in Maturin, and 2 in Barinas-Apure. This was a drop of 40 active drilling wells from the 101 under way at the end of 1958.

By June 8, 1960, there were 45 wells being drilled in Venezuela, including

22 in Maracaibo, 18 in Barcelona, 5 in Maturin and none in Barinas. It appeared that the 1960 completions total might drop as low as 400.

In Barinas-Apure, 11 dry holes were completed in 1959. Interest is lagging there due to the lack of success from recent exploratory efforts.

Total footage in 1959 amounted to 6,091,314 feet of hole, down 30.9 percent from the 8,815,132 figure of 1958. Since completions declined more than footage did, it was clear that wells were being drilled deeper, on the average, in 1959 than in 1958. Total footage in 1957 was 11,118,441.

In Maracaibo district, important extensions were made in fields in the Lake drilled on concessions granted in 1956 and 1957. In addition to the successes by Mene Grande already mentioned, Venezuelan Sun, Superior, Phillips Petroleum, San Jacinto Venezolana C A and Signal Oil and Gas all extended fields described in WORLD OIL, August 15, 1959, pp. 140-141. Also, CSV made a very important discovery a few miles east of Phillips' new oil field south of Lama. VLE 319 well flowed 1,900 bpd of 24.8° API gravity crude. VLE 305 and 326 were even more productive. These wells are in the east and southeast part of Shell's southernmost block in the Lake. The pays are of Eocene and younger age.

On August 10, 1959, Sun announced completion of its thirtieth well in the Lake, SVSX-32, completed as a dual producer testing more than 8,200 bpd from two Eocene sand zones between 8,750 and 9,400 feet. The well flowed 4,380 bpd from the upper and 3,820 bpd from the lower zone, both thru 5/8-inch chokes. No dry holes had been drilled by Sun in the Lake at the time. By March 31, 1960, Sun had completed SVS 39 for 5,000 bpd, and also confirmed a new discovery, SLG 12-3 and a confirmation test, SLG 12-4. These wells are also dual producers, and each tested about 5,000 bpd. This work extends the productive Lama field trend about 4 miles farther southwest in the direction of Phillips' new production.

In Urdaneta field, Creole Petroleum Corp., drilled well A-139-1, a Cretaceous test to 16,402 feet. This was the deepest test drilled in the Lake at the time, although it did not equal the deepest onshore test in Venezuela, which was drilled to 17,537 feet some years ago by CSV. The deep Urdaneta test failed to find production in the Cretaceous.

Superior drilled two exploratory wells, Lama 22 and 28, the former in the extreme northeast corner of the block offsetting both Creole and CSV. Lama 22 was completed in the Santa Barbara sand for 1,150 bpd of 32.2° API gravity crude. Lama 28, located 1½ miles west of 22, offsetting CSV's block, was completed in the Eocene for 1,900 bpd of 40.4° API gravity crude.

In the Barcelona district 41 wildcats were drilled last year, resulting in 17 successful completions. Mene Grande's Zacarias 1 was drilled to 14,964 feet and was completed dually in the L-0 and U-1 sands. The new well apparently extends the Zanjas field, a large stratigraphic trap-type deposit. Zacarias 1 was good for 321 bpd of 42.3° API gravity oil from the L-O sand and 505 bpd of 42.7° API gravity crude from the U-1 sand.

Other important successful wells in the Barcelona district were drilled in the Lazo, Ida, Icon, Nuca, Nivel, Espejos, and other areas. At La Ceiba (previously mentioned in connection with Mene Grande's operations) six stratigraphic wells were drilled last year, revealing a new structure productive from the Oficina and Merecure sands.

In the Maturin district, an important discovery was made in the Orocual area. In the Aguasay area, Sinclair drilled 4 wildcats on seismic prospects and all were completed in Oligocene horizons productive in nearby fields. Significant extensions along faulted trends were evident from this work. Well A-Este-1 was dually completed for 781 bpd of 41.6° API gravity oil from the F-1 sand and for 684 bpd, 39.8° API gravity crude from the F-5 sand. Well A-Este-2 was completed for 730 bpd of 29.1° API gravity crude from the T-1 sand and for 522 bpd of 32.4° API gravity oil from another T-1 zone.

Aguasay 5-A and 6 wells were completed in new fault blocks. Aguasay 5-A was completed for 607 bpd of 33.6° API gravity crude; Aguasay 6 was dually completed for a total of 1,262 bpd.

Production. Crude oil production increased in 1959 to an average of 2,771,012 barrels daily in Venezuela, amounting to a total of 1,011,419,380 barrels (Table 1). This represents an increase of 166,172 bpd or 6.4 percent compared with the 1958 figure of 2,604,840 bpd. The 1959 figure almost equalled the 2,779,245 barrels daily rate of 1957.

Production was not holding up quite so well during the first half of 1960. The 1960 average to June 22 was 2,842,488 bpd, slightly under the 2,854,175 average during the same period in 1959. Any production decline, however, was apparently not too serious, since a high rate was being maintained.

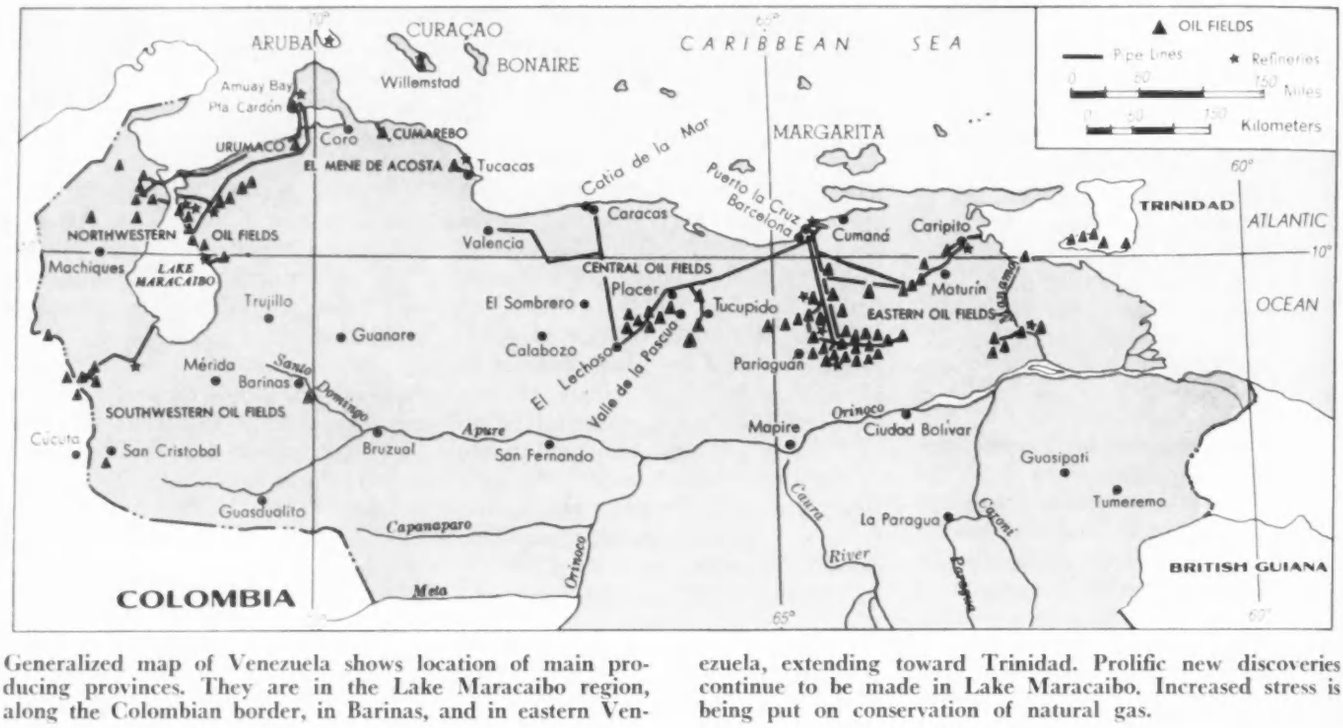
Creole Petroleum Corp. continued to hold its position as largest producer in Venezuela, maintaining more than a million bpd production in 1959. CSV rallied strongly from its 1958 setback to almost 800,000 bpd last year. Some of the newcomers to Venezuela, particularly Sun, San Jacinto, Phillips and Signal made important gains. Others, hampered by U.S. oil import

TABLE 1—Crude Oil Production in Venezuela in 1959 and 1958 by Companies

(Source: Ministry of Mines and Hydrocarbons, Venezuelan Government)

COMPANY	Total Barrels		Barrels Daily		Percent Diff.
	1959	1958	1959	1958	
Creole Petroleum Corporation	404,522,565	391,265,400	1,108,281	1,071,104	+ 3.5
Compania Shell de Venezuela Ltd.	291,161,960	256,849,405	797,704	703,697	+ 13.4
Mene Grande Oil Company	135,270,825	141,963,465	370,605	388,941	— 4.7
Mobil Oil Company de Venezuela	41,349,390	46,580,935	113,286	127,619	— 11.2
Texas Petroleum Company	20,401,675	18,578,500	55,895	50,900	+ 9.8
Richmond Exploration Company	18,170,065	27,454,205	49,781	75,217	— 33.8
Sinclair Venezuelan Oil Company	17,458,315	22,459,545	47,831	61,533	— 22.3
Venezuelan Sun Oil Company	16,035,180	4,417,595	43,932	12,103	+263.0
San Jacinto Venezolano, C. A.	12,685,575	3,168,565	34,755	8,681	+302.7
S. A. Petrolera Las Mercedes	11,659,195	12,434,820	31,943	34,068	— 6.2
Phillips Petroleum Company	10,617,485	4,238,745	29,089	11,613	+150.5
Venezuelan Atlantic Refining Company	9,440,725	10,198,465	25,865	27,941	— 14.6
Signal Oil and Gas of Venezuela	9,014,040	1,195,375	24,696	3,275	+654.1
Colon Oil Company, Ltd.	7,278,100		19,940		
Superior Oil Company of Venezuela	5,873,580	9,609,355	16,092	26,327	— 38.9
Talon Petroleum Company	464,280	577,795	1,272	1,583	— 24.4
Caracas Petroleum Company	11,680	9,855	32	27	+ 18.5
Coro Petroleum Company	2,920	22,630	8	62	— 87.0
Continental Oil Co. of Venezuela	1,825	23,725	5	65	— 92.3
Pan Venezuelan Oil Company		30,660		84	
Total Venezuela	1,011,419,380	951,079,040	2,771,012	2,604,840	

OIL FIELDS, PIPE LINES AND REFINERIES OF VENEZUELA



Generalized map of Venezuela shows location of main producing provinces. They are in the Lake Maracaibo region, along the Colombian border, in Barinas, and in eastern Venezuela, extending toward Trinidad. Prolific new discoveries continue to be made in Lake Maracaibo. Increased stress is being put on conservation of natural gas.

curbs, notably Sinclair and Atlantic, cut back production. Richmond Exploration Co. appeared unable to offset depletion of its holdings with new wells. This situation may develop in the case of numerous concessionaires as the no-new-grants policy of the Venezuelan government continues.

Of the 1959 production, 10.24 percent by volume was of crude of 14° API gravity or less; 21.21 percent was in the 14.0-24.9° API gravity range; and 68.55 percent was above 24.9° API gravity. At the end of 1959, a total of 10,411 oil wells were reported producing, compared with 10,375 at the end of 1958.

Late in 1959, Venezuelan Sun Oil Company, operating for itself and Venezuelan Atlantic and Texaco-Seaboard, completed a new fully-automated flow station in Lake Maracaibo. The new station is capable of gathering, separating, stabilizing, testing, and moving 100,000 bpd of crude from more than 30 wells. It also provides its own fuel to power its equipment. An operator in a central control room on a platform a mile away monitors the station's operations as they are transmitted by radio signals. The operator also watches the oil flow from wells on a visual panel.

Gas is separated from crude in the third (top) deck of the station. Degassed oil flows into an aluminum caisson 91 feet long and 8 feet in diameter suspended from the lower deck into the water. Basic silt and water produced in the wells sink to the bottom. Oil is lifted from the caisson by booster pumps to the main discharge pumps on the second deck, and moved to storage 35 miles away via an 18-inch pipe line.

Unitization of the lower Lagunillas reservoir in southwest Bachaquero field in the Lake will be achieved pursuant to a pact signed on March 17, 1960, between Creole, CSV, Mene Grande and San Jacinto. Reserves are estimated at 600 million barrels, although more than 85.6 million barrels have been produced from this zone. This multicompany deal covers one of the largest unitization projects in the world, and will entail an extensive secondary recovery project.

Phillips Petroleum Co. was in the process of automating its large field in Lake Maracaibo in 1960. Production would be coordinated and remotely controlled from a central panel.

Reserves. Crude oil reserves in Venezuela at the end of 1959 were estimated at 16,875,533,000 barrels. This represents a very slight increase above the 16,800 million barrels estimated at the end of 1958. New reserves proved in 1959 thus just barely offset production. However, Venezuela also had 245,302,200 barrels of proven reserves of hydrocarbon liquids (condensate and LPG).

Natural gas reserves were placed at 33,399,726 MMcf as of December 31, 1959, about equal to the 33,348,060 MMcf figure of a year earlier. The ratio of production to reserves was 6.0 percent as to crude and 2.3 percent as to natural gas in 1959.

Pipe lines. CSV completed construction of a 30/34-inch line from Bachaquero and Lagunillas fields to Puerto Miranda, described fully in last year's report (see WORLD OIL, August 15, 1959, page 142) by the end of 1959, and the Puerto Miranda terminal was equipped to handle supertankers.

Venezuelan Sun completed a 35-mile, 18-inch line in the Lake (mentioned previously) to storage at Punta de Palmas.

Exports. Venezuela exported 719,835,469 barrels of crude and 218,422,369 barrels of products in 1959, an average of 1,972,152 barrels of crude daily and 598,417 bpd of products.

Hence, 92.8 percent of Venezuela's petroleum output was exported last year. These figures are compared with 1,904,178 bpd of crude and 553,028 bpd of products exported in 1958. Hence, exports of both crude and products increased in 1959.

Refining. Crude oil charged to stills in Venezuela averaged 824,043 bpd in 1959, 8.9 percent more than the 731,795 bpd in 1958. The volume of Venezuelan crude refined domestically rose to 29.7 of the crude produced last year, compared to 28.1 percent in 1958.

Important refinery projects last year included construction of Mobil Oil Co. of Venezuela's 56,000 bpd El Palito plant at Puerto Cabello to process Barinas crude. This plant went on stream in 1960.

Taxes. The Venezuelan government reported collection of $967,506,654.60 in taxes from the oil industry in 1959. This represents an increase from the $814,766,514.00 reported in 1958.

Natural gas. Production of natural gas increased about one percent in 1959. Total production was 1,124,294 MMcf, an average of 3,080 MMcf daily. The 1958 average was 3,049 MMcf daily. Utilization of natural gas continued to increase rapidly. The 1959 breakdown as to disposition of natural gas was as follows:

- 344,005 MMcf (942 MMcf daily), 30.5 percent, injected to maintain pressure in oil reservoirs
- 61,756 MMcf (170 MMcf daily), 5.5 percent, used as fuel subject to tax
- 36,586 MMcf (100 MMcf daily), 3.3 percent, sold, not subject to tax
- 32,777 MMcf (90 MMcf daily), 2.9 percent, used as fuel not subject to tax
- 19,660 MMcf (54 MMcf daily), 1.8 percent transformed to natural gasoline and LPG
- 16,911 MMcf (46 MMcf daily), 1.5 percent, sold subject to tax
- 612,599 MMcf (1,678 MMcf daily), 54.5 percent, flared. Since the proportion of flared gas in 1958 was 56.3 percent, it was clear that utilization of gas in Venezuela was being steadily increased, and the government was pushing gas conservation more strongly.

Toward the end of 1959, there were 39 injection plants with an average capacity of 942.5 million cubic feet daily, distributed among 72 different sands. These projects are expected to increase oil recovery by more than one billion barrels. Six such plants were under construction and 21 more are planned for the near future.

New government company. Corporacion Venezolano del Petroleo, a wholly owned government entity, was created by a decree dated April 19, 1960. The company is authorized to explore for, exploit, refine, transport and market oil and to engage in related activities, including petrochemicals. The Minister of Mines and Hydrocarbons will head the board of directors. The company was expected to drill near or in proven tracts on previously ungranted areas, very likely in Lake Maracaibo first.

TABLE 2—Drilling Activity in Venezuela in 1959, by Companies and Districts

(Source: Ministry of Mines and Hydrocarbons, Venezuelan Government)

Company and District	Wells Completed				Producing Wells Completed				Other Wells Completed		Wells Drilling at End of 1959	Wells Suspended During 1959	Wells Recompleted
	Exploitation	Semi-Wildcats	Wildcats	Total	Exploitation	Semi-Wildcats	Wildcats	Total	Injection Wells	Dry Holes			
DATA BY COMPANIES													
Creole, Total	65	25	19	109	61	14	6	81	1	27	8	3	2
Maracaibo	55	3	8	66	52	3	4	59	1	6	6	3	1
Barcelona	5	22	1	28	4	11	1	16	....	12	1	....	....
Maturin	5	....	8	13	5	....	1	6	....	7	1	....	1
Barinas	....	....	2	2	....	....	....	....	....	2	....	....	....
Shell, Maracaibo	65	11	6	82	65	11	4	80	....	2	9	13	1
Mene Grande, Total	71	141	16	228	68	106	7	181	1	46	13	4	....
Maracaibo	4	17	1	22	4	15	1	20	....	2	3	2	....
Barcelona	66	121	15	202	63	88	6	157	1	44	10	2	....
Maturin	1	3	....	4	1	3	....	4	....	....	....	....	....
Richmond, Maracaibo	....	1	2	3	....	....	....	....	....	3	....	....	....
Texas, Total	40	....	4	44	37	....	2	39	1	4	4	....	....
Barcelona	39	....	3	42	36	....	1	37	1	4	4	....	....
Maturin	1	....	1	2	1	....	1	2	....	....	....	....	....
Colon, Maracaibo	3	4	3	10	3	3	1	7	....	3	1	1	....
Signal, Maracaibo	3	7	2	12	3	6	2	11	....	1	3	2	....
Venezuelan Sun, Maracaibo	1	11	5	17	1	11	4	16	....	1	2	....	....
Superior, Maracaibo	4	5	4	13	4	4	4	12	....	1	....	....	....
San Jacinto, Maracaibo	1	5	4	10	....	2	3	5	....	5	1	1	....
Phillips, Total	2	9	1	12	2	9	....	11	....	1	2	1	....
Maracaibo	2	9	....	11	2	9	....	11	....	....	1	1	....
Barcelona	....	....	1	1	....	....	....	....	....	1	1	....	....
Mobil Oil, Total	53	24	11	88	43	20	5	68	7	13	13	9	....
Barcelona	53	24	8	85	43	20	5	68	7	10	10	7	....
Barinas	....	....	3	3	....	....	....	....	....	3	2	2	....
Maturin	....	....	....	....	....	....	....	....	....	....	1	....	....
Varco, Total	19	2	10	31	19	1	5	25	....	6	....	4	....
Barcelona	1	....	5	6	1	....	2	3	....	3	....	....	....
Maturin	18	2	5	25	18	1	3	22	....	3	....	3	....
Barinas	....	....	....	....	....	....	....	....	....	....	....	1	....
Petmer, Total	11	4	10	25	6	4	2	12	....	13	....	1	1
Barcelona	10	....	8	18	5	....	2	7	....	11	....	....	1
Maturin	1	4	2	7	1	4	....	5	....	2	....	1	....
Sinclair, Total	5	2	9	16	5	2	4	11	....	5	2	1	....
Barcelona	....	....	....	....	....	....	....	....	....	....	1	....	....
Maturin	5	....	5	10	5	....	4	9	....	1	1	1	....
Barinas	....	2	4	6	....	2	....	2	....	4	....	....	....
Pan Venezuelan, Maturin	....	....	....	....	....	....	....	....	....	....	1	....	....
Continental, Maturin	....	1	4	5	....	1	....	1	....	4	2	....	....
King Mill, Barinas	....	....	2	2	....	....	....	....	....	2	....	....	....
DISTRICT TOTALS													
Maracaibo	138	73	35	246	134	64	23	221	1	24	26	23	2
Barcelona	174	167	41	382	152	119	17	288	9	85	27	9	1
Maturin	31	10	25	66	31	9	9	49	....	17	6	5	1
Barinas	....	2	11	13	....	2	....	2	....	11	2	3	....
Total, Venezuela	343	252	112	707	317	194	49	560	10	137	61	40	4

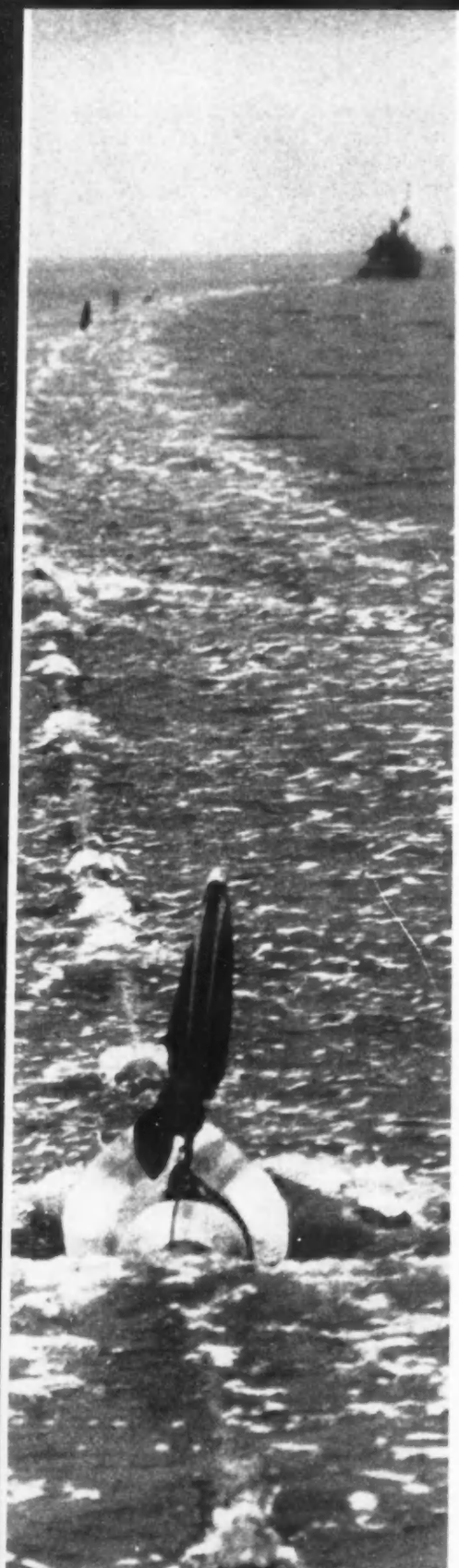


Photo courtesy PRAKLA

A seismometer spread is dragged by a recording boat in marine exploratory work in North Sea. As in the case of an increasing number of nations, there is interest in offshore oil possibilities in West Germany. A deep test is also to be drilled offshore from Holland, based on seismic work. (See Page 139 for details on West Germany.)

Stronger Economy Boosts Activity on the Continent

Exploration, drilling and production all on increase during 1959 and 1960

EUROPE'S OIL AND GAS exploration, drilling, and producing efforts were increasing in intensity in 1959 and 1960, stimulated by the generally prosperous situation in Western Europe and the increasing tendency of the Continent to base its economy on oil and gas.

The superabundance of conventional fuels, including oil from the Middle East, the Sahara and Russia, and natural gas in France, The Netherlands and West Germany, has caused Europe to renew its confidence in readily-available oil and gas at reasonable prices. This ready local market for indigenously-produced oil and gas has, in turn, stimulated drilling and producing operations in many places in Europe.

This is particularly so in the Paris Basin of France, where a ready crude oil market, shallow drilling depths, and relatively high crude yield have stimulated drilling, and production had reached about 8,700 bpd by mid-1960.

The Soviet Union continues to boost crude oil production, for two important reasons: (1) the Russians are now convinced that their expanded future economy can best be based primarily on oil and natural gas, rather than on coal and hydroelectric power; and (2) in order to generate foreign exchange and to

make the satellite nations economically dependent on Russia for essential fuels, a surplus for export must be created.

Crude oil output was also being increased in Sicily, West Germany, and Yugoslavia. Exploration has yielded important new sources of natural gas in Italy. Active exploration continues and is increasing in Spain, where a new drilling depth record was set last year.

Western Europe . . . oil development proceeds steadily and gas becomes more important

CRUDE OIL PRODUCTION increased in France last year, stimulated by output from the new Paris Basin fields. By mid-1960 daily crude oil yield from Coulommes, Chateaurenard, Chailly, Chartrettes, Bossenay, Rigny-la-Noneuse and St. Fermin des Bois fields in the Paris Basin was approaching 8,700 bpd, augmenting production from the Aquitaine Basin and Rhine Graben.

In England, a new producing province in the extreme south in Dorset had been established, and offshore areas between southern Britain and Normandy were enhanced.

Oil production in Sicily continued to increase with expanded output from Ragusa field. Although Gela field output was limited owing to the difficulty in utilizing the high-sulfur-content crude, a new petrochemicals plant was authorized at Gela to process up to 50,000 bpd.

Intensive exploration in West Germany yielded a number of discoveries in 1959, including the important new Loeningen oil field in Weser-Ems and significant gas fields at Buchhorst in Weser-Ems and Esche and Wielen in Emsland.

In western Austria, Rohoel Gewinnungs A G evidently found the first important oil field in the Molasse at Ried 1, about 35 miles west of Linz. Drilling activity was being stimulated in Switzerland, with several wildcats under way in mid-1960.

Natural gas was assuming increased importance in western Europe. In France, expansion of processing facilities at Lacq enabled fuller utilization of this huge sour gas deposit. Natural gas is also becoming more important in Italy and West Germany as more reserves are proved, and remains of high value in Holland.

Austria . . . crude production declines 13.3 percent in 1959, following similar decrease in 1958

AFTER YEARS OF NEGOTIATIONS concerning indemnification of Western oil firms for losses suffered during Austria's occupation (1938-1945), an agreement finally was reached with the Austrian state.

Accordingly, RAG (Shell/Vacuum) is to get $13.7 million in installments for lost concessions and Crude Utilization Company (state company OeMV, 74 percent; Mobil Oil, 13 percent; Shell, 13 percent), is to be set up to regulate imports and crude runs to refineries. However, ratification of this agreement is still outstanding.

Meanwhile, during his propaganda-filled visit in early July, Krushchev hinted that Austrian oil reparations to Russia might be turned into a trade agreement.

Following a request by the Austrian government, the Soviet Union agreed in October 1958, to reduce the outstanding delivery of 49 million barrels of crude oil by half. Moscow's only stipulation: Austria was to continue its deliveries as usual, while the Soviet Union was to ship to Austria 24.5 million barrels of crude oil in yearly installments of 3.5 million barrels, starting in January 1959.

It is believed that these Soviet crude oil deliveries are to serve as bait for further purchases, and that Austria may thus be induced to adjust refineries to the processing of sulfur-rich Soviet crude oil.

Production declines again. Crude oil output last year averaged 46,427 barrels per day. This was 13.3 percent less than in 1958. Production dropped 11.3 percent in 1958, to 53,557 bpd.

Natural production decline has been given as the reason for this downward trend. On the other hand, natural gas production totaled 39.8 billion cubic feet last year, 46 percent above 1958.

Reserves. A reassessment of reserves in Lower Austria province as of January 1, 1959, caried out on the basis of latest experience, led to a downward correction of crude oil reserves. The revised figures: 267,513,000 barrels of crude oil, 529.6 billion cubic feet of dry gas, and about 353.1 billion cubic feet of wet gas.

Ninety-one percent of the crude oil reserves are stored in the Matzen field, which at present accounts for 83 percent of total production.

Drilling activity. Eighty-two wells were drilled in 1959, compared with 93 in 1958. Of last year's total, 65 were developed wells (62 productive, 3 dry), and 17 were wildcats (1 oil, 4 gas, 12 dry).

There are four companies in Austria, of which OeMV and RAG are prospecting and producing, Van Sickle is producing and Vorarlberger Erdoelges, is wildcatting.

State company OeMV last year produced 15,865,356 barrels of crude

Crude Oil Production in Austria Continues to Decline

COMPANY	TOTAL BARRELS			BARRELS DAILY		
	1959	1958	1957	1959	1958	1957
Austrian Mineral Oil Administration (state company) (OeMV)	15,865,356	18,330,060	20,726,484	43,467	50,219	56,785
Erdoel Produktions Gesellschaft (state company, 50% OeMV-owned) (EPG)	*	224,190	248,498	*	614	681
Rohoelgewinnungs Gesellschaft (Socony-Shell of U.S.A.) (RAG)	1,080,499	798,872	790,506	2,960	2,189	2,166
Van Sickle (Canadian Company)		195,319	189,647		535	520
Total	16,945,499	19,548,441	21,955,153	46,427	53,557	60,152

*In June, 1959, EPG was merged with the Austrian Mineral Oil Administration (OeMV).

AUSTRIA

(43,467 bpd), about 93 percent of the total. It invested $20.5 million (1958, $26.9 million), of which $9.7 million were spent on construction of the new Schwechat refinery $5.7 million on exploration, and $2.7 million on production installations.

Footage drilled last year totaled 164,050 feet for exploration, 127,073 feet for production, 32,252 feet for extension, 31,005 feet for water injection and 32,810 feet for structural tests.

The four seismic crews, which OeMV had in the field throughout 1959, were reduced this year to two. Seismic and gravimetric surveys concentrated on prospective areas in the Vienna Basin and in the St. Poelten area.

At Aderklaa, the country's first gas horizon in Triassic was discovered at 9,257 feet, with the relatively high pressure of 4,260 psi, compared with 2,130 psi in Zwerndorf gas field. Shot perforations at exploratory well Althoeflein 1 between 738 feet and 761 feet opened a new gas field in Tortonian.

Exploratory well Tallesbrunn 1, located between Zwerndorf and Matzen encountered between 3,091 and 3,124 feet a rich gas horizon. Tallesbrunn 2, 2,297 feet southeast of No. 1 struck gas in the same formation and almost same depth. Exploratory well Himberg 1 yielded gas from a depth of 4,222 feet to 4,239 feet with a pressure of 1,522 lb/sqin through a 0.234″ choke.

Since well Uebersbach 1, Styria province, had to be abandoned as dry, RAG is concentrating its activity on its concession in Upper Austria province. To date this company has invested in this concession more than $9.12 million; revenues amounted to a mere $600,000.

RAG has drilled 20 deep wells with a total footage of 143,849 feet and 7,014 shot holes with a cumulative depth of 940,341 feet. Through discovery of the Ried oil field, with reserves estimated at 7 million barrels, the company may eventually be able to balance its budget.

RAG has in Upper Austria province 7 wells in production, one at Puchkirchen, two at Steindlberg and four at Ried. Four more wells are drilling at Ried.

West Germany's "Preussag Company" is drilling for "Vorarlberger Erdoelges.m.b.H." the first wildcat in Austria's westernmost province. At 8,055 feet, well "Dornbirn 1" showed traces of gas. The well is to be drilled to 8,143 feet. "Preussag" is drilling at its own expenses, but will share in profits if "Dornbirn 1" is productive.

Refining. Primary capacity of Austria's eight refineries remained unchanged last year at about 48,000 bpd. Private companies (Shell, Vacuum, Van Sickle) own 20 percent, state company OeMV the rest of the capacity. Vacuum Oil Company (refining) and Mobil Oil Austria AG. (marketing), were merged into Mobil Oil Austria Aktiengesellschaft.

Construction on OeMV's new Schwechat refinery, which, after completion, is to replace the company's four obsolete plants, is progressing as scheduled. The first construction stage will have a capacity of 32,000 bpd. This year the catalytic reforming plant is to be completed.

Imports needed. Due to the steady decline in crude production and the increase in consumption of petroleum products at an average annual rate of 10 percent, imports are rising correspondingly.

Belgium . . . some interest developing

THERE WAS no drilling for oil and gas in Belgium in 1959. Societe Campinoise de Recherches et d'Exploitations Minieres still had not begun exploration in northwest Belgium. The Royal Dutch Shell Group has recently applied for an exploration and development permit covering 650,000 acres in southern Belgium, probably on the basis of gravity data.

Denmark . . . exploration program ceases

DENMARK'S ONLY active operator, Standard of New Jersey affiliate Danish American Prospecting Co. (DAPCO), completed two wildcat dry holes on the island of Zealand in 1959, drilling a total of 17,766 feet of hole. In all, DAPCO drilled 11 dry holes (total footage: 70,032 feet) during 1958-59.

Completion of the last two wells in the first part of 1959 terminated DAPCO's drilling and exploration program in Denmark. As of June 1959, the company relinquished all concessions in the country.

The one industry bright spot in Denmark was provided by Tidewater Oil Co. subsidiary Dansk Veedol, which announced that contracts have been awarded for the construction of a 20,000-bpd refinery at the port of Kalundborg. The refinery is expected to be on stream by September 1961.

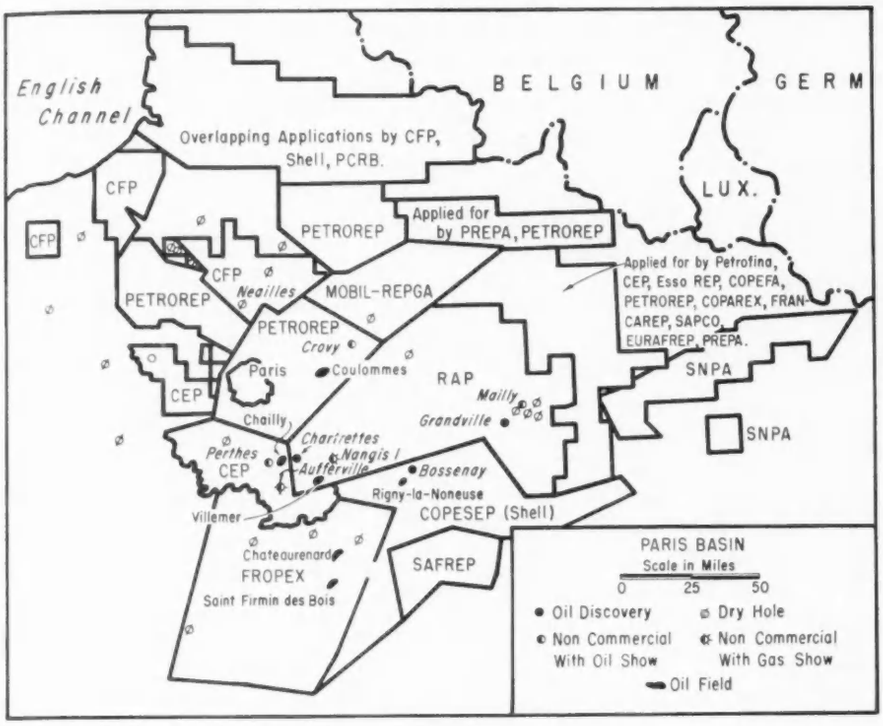
Eire . . . exploration is proceeding

IRELAND'S OIL exploration program took a step forward in late November 1959 when the Petroleum and Other Minerals Development Bill, 1959, was passed by the Republic of Ireland's legislature. The bill went into effect early in 1960.

Due to the bill's passing, Ambassador Irish Oil Co., an Irish registered company and wholly owned subsidiary of Ambassador Oil Corp. of Fort Worth, Texas, completed negotiations and reached an agreement with Ireland. Under the pact, Ambassador Irish Oil obtained exclusive exploration rights in the Republic for the first five years; for a second five-year period, 75 percent of the country; for five more years, 50 percent of the country; and still another five years, on 25 percent of the country, provided the company fulfills all conditions of the agreement.

The new bill vests in the Minister for Industry and Commerce all authority in petroleum matters. The legislation now enacted is not concerned with general proprietary rights in land, but only with the divesting of private rights in petroleum and their transfer to the government, thereupon proceeding to "make further and better provision for the working and development of petroleum," amending the Mineral Development Act of 1940.

OIL FIELDS AND IMPORTANT WILDCATS IN PARIS BASIN, FRANCE



France . . . Paris Basin oil and Lacq gas boost country's economy; crude production rises sharply

METROPOLITAN FRANCE has become an important oil and gas producing country. During the past two years the Paris Basin has been proven as a significant oil province, and new crude production therefrom has more than offset depletion of older Rhine Graben and Aquitaine Basin sources. Facilities for processing and distributing natural gas from the large deep Lacq gas field in southern France continue to be developed and expanded, making natural gas an important part of France's expanding economy.

Paris Basin discoveries. Three new oil fields were discovered during the 12-month period from May 1, 1959 to May 1, 1960 (Table 1; and WORLD OIL, August 15, 1959, page 147). Development continued in Coulommes, Chateaurenard, Chailly, Chartrettes and Bossenay fields. New crude sources were found at Villemer, 38 miles southeast of Paris, at Rigny-la-Noneuse, 35 miles east of Villemer, and at Saint Fermin des Bois, a short distance southwest of Chateaurenard. Paris Basin fields were producing 8,700 bpd in mid-1960, against only 2,000 bpd a year earlier.

The Dogger formation (Jurassic) accounts for the great majority of current production, although some Cretaceous sands produce at Chateaurenard and Saint Fermin. The most important 1959 discovery was made by Regie Autonome des Petroles (RAP) at Villemer in October. By mid-1960 the field had 5 producers yielding more than 500 bpd. The field was not yet delineated, although an attempted 2-mile stepout to the northeast was said to have recovered salt water on a test.

Crude oil production increased in France last year to 11,712,828 barrels, an average of 32,090 bpd, up 16.7 percent from the 27,506 bpd average of 1958 (Table 2). France's biggest oil deposit, Esso REP's Parentis field in the southwestern portion of the Aquitaine Basin, boosted output to 24,682 bpd last year, 3 percent above the 1958 rate. Twenty-six wells were on production at the end of 1959.

Esso also had 6 producing wells at Lugos, 4 at Mothes, and 1 at Lucats oil fields in the Parentis vicinity at the end of 1959, and three oil producers had been completed at Cazaux, about 20 miles north of Parentis on the Atlantic coast. The discovery was made in mid-1959, and 54,972 barrels of 32° API gravity oil was produced last year. By April 1960, five wells were flowing at a combined rate of 1,682 bpd. Aptian and Albian sandstones (Cretaceous) are productive.

Cazaux 4 was perforated from 8,727 to 8,783 feet and from 8,612 to 8,631 feet and completed late in April, initially flowing 787 bpd. Total depth was 9,514 feet. Cazaux 6 was drilled to about 9,000 feet in tight Neocomian sandstone, equivalent to the main pay zone at Parentis. About 50 feet of oil-saturated Aptian-Albian

TABLE 1—Indicated commercial crude oil discoveries in the Paris Basin, France, May 1, 1960

Field or Well Name and OPERATOR[1]	Completion Date of Discovery	Exploration Method	Type of Trap	Reservoir			Wells			BPD Production	Oil Gravity API	Remarks
				Depth in Feet	Lithology	Age	Producers	Dry	Drilling			
Recent Discoveries:												
Villemer, RAP	Oct. 1959	seismic	anticline	5,000	limestone	Dogger[9]	5	..	1	500	..	Field not defined yet.
Rigny-la-Noneuse, COPESEP	Dec. 1959	seis; sub[4]	fault (?)	5,000	limestone	Dogger[9]	1	..	..	.....	..	On pump
Saint Fermin des Bois, FROPEX	Feb. 1960	subsurface	strat[6]	2,000	sand	Neocomian[10]	1	1	..	30	25	.....
Earlier Discoveries[2]												
Coulommes, PETROREP	Mar. 1958	seis; str[5]	anticline	6,000	oolit-ls[8]	Dogger[9]	29	2	..	3,800	33	Undersat. crude[11]
Chateaurenard, FROPEX	Apr. 1958	seismic	pinchout[7]	1,800	sand	L. Cret.[10]	5	6	..	350	25	No gas, water cut
Chailly, CEP	Oct. 1958	seismic	anticline	5,500	limestone	Dogger[9]	24	2	1	1,600	35	Water cut.
Chartrettes[3], RAP	Mar. 1959	seis; sub[4]	anticline	5,400	limestone	Dogger[9]	9	2	1	450	34	Testing.
Bossenay, COPESEP	Apr. 1959	seismic	fault	4,600	limestone	Dogger[9]	9	1	..	2,000	31.9	Testing

[1] For full names of companies see Footnote 1 of Table 2. [2] Previously tabulated in WORLD OIL, Aug. 15, 1959, page 147. [3] Listed previously in WORLD OIL as Brie 101, the discovery well. [4] Seismic and subsurface. [5] Seismic and structure drill. [6] Stratigraphic. [7] On faulted anticline. [8] Oolitic limestone. [9] Middle Jurassic. [10] Lower Cretaceous. [11] Undersaturated Crude. Water drive.

sandstones were found in Cazaux 6. Cazaux 7 was drilling below 7,316 feet on May 1.

Natural gas production increased strongly in 1959, the first full year when the second stage of the Lacq natural gasoline plant was on stream. The second stage entered operation in October 1958. Raw gas offtake at Lacq amounted to almost 80 billion cubic feet last year, averaging more than 217 MMcf feet daily. Gas from the deep Lacq (Neocomian limestone) pay zone contains 16.8 percent by volume of hydrogen sulfide and 8.2 percent carbon dioxide. The natural gasoline plant is highly efficient, and about 72 percent of the raw gas offtake is converted to high-methane pipe line gas after extraction of sulfur and the heavier hydrocarbon liquids (WORLD OIL, June 1960, page 167, and PETROLEUM REFINER, February 1959, page 174).

Societe Nationale des Petroles d'Aquitaine (SNPA) recovered 1,103,500 barrels of butane, propane, and natural gasoline last year and about 485,000 metric tons of sulfur at Lacq. Natural gas production by RAP at the old St. Marcet gas field amounted to 10,282 MMcf in 1959 (28,170 Mcf daily), down slightly from 31,629 Mcf daily reported in 1958. RAP also recovered 206,000 barrels of propane, butane, and natural gasoline at St. Marcet. Esso REP produced 75 MMcf in 1959, an average of 205 Mcf daily compared to 192 Mcf daily in 1958.

SNPA was producing about 225 MMcf daily in 1960, and expected to produce Lacq gas at the rate of 450 MMcf daily in 1961. Facilities to handle up to 750 MMcf of raw gas daily were expected to be on stream by the end of this year. A vast petrochemicals complex is developing at Lacq.

Twenty-six gas wells had been completed at Lacq by the end of 1959. SNPA, Gaz de France, and Compagnie Francaise du Methane are partners in a large 16-to-24-inch pipe line project under way to move Lacq gas to Paris, Nantes, Lyon, Chalons, and many other cities. Demand for gas is growing along the main 24-inch line south of Paris, and the government is discouraging industrial sales of Lacq gas in the Paris area in line with its program to decentralize industry.

Drilling continued to increase in intensity in 1959, when 201 wells were completed compared with 184 in 1958. In addition, SNPA completed 23 injection wells for gas storage at Lussagnet last year. The 201 completions tabulated in Table 2 amounted to a total of 1,418,783 feet of hole in 1959, compared with

TABLE 2—Crude Oil Production and Drilling in France in 1959, by Companies, Basins, and Fields

Adapted from *Petrole Informations* and The American Association of Petroleum Geologists *Bulletin*

Company[1], Basin—Field	CRUDE OIL PRODUCTION: Total Barrels 1959	Total Barrels 1958	Barrels Daily 1959	Barrels Daily 1958	% Diff. 1959–1958	Oil Gravity, API°	WELLS COMPLETED IN 1959: Oil	Gas	Dry	Total	Total Footage	Wells Drilling at End of 1959
ESSO REP:	**9,008,891**	**8,755,113**	**24,682**	**23,968**	**+ 3.0**	...	**2**		**13**	**15**	**147,679**	**4**
Aquitaine Basin	**9,008,891**	**8,755,113**	**24,682**	**23,968**	**+ 3.0**							
Parentis	8,278,487	8,184,936	22,681	22,424	+ 1.1	33						
Mothes	434,703	312,116	1,191	855	+ 39.3	21			1	1	8,451	
Lugos	222,121	254,891	609	698	— 12.8	20.5						
Cazaux	54,972		151			32	2			2	20,380	2
Lucats	18,608	3,170	50	9	+455.6	38						
SNPA:	**666,270**	**689,458**	**1,825**	**1,889**	**— 3.9**	**19.6**	**1**	**13**	**10**	**24[3]**	**350,947**	**8**
Aquitaine Basin, Lacq[2]	**666,270**	**689,458**	**1,825**	**1,889**	**— 3.9**	**19.6**		**12**		**12**	**152,204**	
RAP:	**80,683[4]**		**221**			**34**	**9**		**19**	**28**	**191,878**	**5**
Aquitaine and Paris Basins	**80,683[4]**		**221**			**34**	**9**		**19**	**28**	**191,878**	**5**
PREPA:	**334,582**	**306,145**	**917**	**839**	**+ 9.3**		**3**		**19**	**22**	**119,785**	**4**
Rhine Graben	**334,582**	**306,145**	**917**	**839**	**+ 9.3**							
Scheibenhard	252,332	198,460	691	544	— 21.3	32	3		3	6	18,612	
Eschau	31,286	42,830	86	117	— 26.5	32						
Donau	25,964	37,545	72	103	— 30.1	30						
Others	25,000	27,310	68	69	— 1.4	30 to 40.5						
PETROREP:	**1,043,650**	**85,749**	**2,859**	**235**	**+1,116.6**	**33**	**21**		**11**	**32**	**166,451**	**1**
Paris Basin	**1,043,650**	**85,749**	**2,859**	**235**	**+1,116.6**	**33**	**21**		**11**	**32**	**166,451**	**1**
Coulommes	1,043,650	85,749	2,859	235	+1,116.6	33	21			21	125,000	
PECHELBRONN:												
Rhine Graben, Pechelbronn	**160,659**	**189,375**	**440**	**519**	**— 15.2**	**26.7**						
CEP:	**169,433**	**5,299**	**464**	**15**	**+2,993.3**		**15**		**11**	**26**	**207,071**	**4**
Languedoc and Paris Basins	**169,433**	**5,299**	**464**	**15**	**+2,993.3**		**15**		**11**	**26**	**207,071**	**4**
Languedoc Basin, Gallician	1,660	2,421	5	7	— 28.6	32						
Paris Basin, Chailly	167,773	2,878	459	8	+5,650.0	35	15		2	17	89,447	3
COPESEP:	**139,882**		**383**			**31.9**	**6**		**3**	**9**	**49,674**	**1**
Paris Basin, Bossenay	**139,882**		**383**			**31.9**	**5**		**3**	**8**	**43,126**	**1**
SPV:												
Rhone and Aquitaine Basins									**7**	**7**	**32,799**	**2**
FROPEX:												
Paris Basin	**108,778**	**8,610**	**298**	**23**	**+836.4**	**21.1 and 27.4**	**2**		**15**	**17**	**47,992**	
Chateaurenard	108,778	8,610	298	23	+836.4	21.1 and 27.4	2		4	6	11,891	
Others										**21**	**104,507**	**3**
Total	**11,712,828**	**10,029,749**	**32,090**	**27,506**	**+ 16.7**		**59**	**13**	**129**	**201[3]**	**1,418,783**	**32**

[1] Names of companies abbreviated here are as follows: Esso REP, Societe Esso de Recherches et Exploitation Petrolieres; SNPA, Societe Nationale des Petroles d'Aquitaine; RAP, Regie Autonome des Petroles; PREPA, Societe de Prospection et Exploitations Petrolieres en Alsace; PETROREP, Societe Petroliere de Recherches dans la Region Parisienne; CEP, Compagnie d'Exploration Petroliere; SPV, Societe des Petroles de Valence; COPESEP, Compagnie des Petroles de Sud-Est Parisien; FROPEX, France-Outre-Mer de Prospections et d'Exploitations Petrolieres S A F. [2] Oil production from upper zone, gas from lower zone. [3] Excludes 23 gas injection wells drilled for a storage project. [4] From Chartrettes field, Paris Basin.

1,499,155 feet in 1958. More than 30 rigs were active at the end of last December, and 37 were reported drilling in April 1960. As deep drilling at Lacq slacks off and shallower drilling in the Paris Basin intensifies, completions are expected to remain at a high rate, although footage may not increase this year.

Refining. Esso completed its new 31,500 bpd Bordeaux refinery in 1959. The new plant charges Parentis crude which flows through a 12-inch pipe line from the field.

A new 70,000 bpd Strasbourg refinery was planned by Compagnie Francaise des Petroles, Compagnie Francaise de Raffinage and Pechelbronn, to operate on Sahara crude moved via a new large-diameter pipe line to be built from the Mediterranean coast up the Rhone Valley into Alsace.

West Germany . . . accelerated exploration leads to new field discoveries; production up

Four of the 21 new oil and gas fields discovered last year in West Germany's continuing accelerated exploration aimed at reducing the current wide margin between domestic demand and supply have proved to be commercial. They are the Loeningen oil field in Weser-Ems and the three naural gas fields of Buchhorst, also in Weser-Ems, and Esche and Wielen, in Emsland.

Despite intensive exploration programs last year, a slight loss was registered in the nation's oil self-sufficiency. Last year, domestic crude output satisfied 21.5 percent of demand, whereas during 1958, national production fulfilled 23.3 percent of demand.

Drilling. Total footage drilled in 1959 amounted to 2,470,025 feet, or 96,500 feet less than during 1958. Of the 409 development wells completed last year, 300 discovered oil, 18 found gas and 91 were dry. Of the 99 wildcat tests completed, 14 found oil, 7 reported gas, and 78 were dry holes.

At year's end, 105 wells were being drilled, 7 fewer than at the same period of the previous year.

Production. In 1959 Western German crude production amounted to 36,229,582 barrels, or an average of 99,259 barrels daily, as compared with the 31,464,332 barrels (86,203 bpd) produced in 1958.

While continued increased production is predicted, it is not expected to equal the 15 percent rise last year. By 1963, daily crude output may jump to 120,000 bpd.

Natural gas production rose 12.7 percent in 1959 with the output of 13.7 billion cubic feet, 1.5 billion cubic feet more than in 1958.

A marked gain was recorded in Bavaria, which doubled its output in 1959. The Weitermuhle gas field now ranks second to the Rehden field near Diepholz.

Toward this end, a new gas pipe line is being laid from Bentheim to the Ruhr industrial district.

Last year, West Germany had 102 gas producing wells, 30 more than a year before.

The increase in crude oil production last year was spread over all producing provinces. The largest increase stemmed from Hanover and the Weser-Ems area which reported increases of 21.2 and 20 percent, respectively.

Reserves. German Geological Survey estimates of crude reserves reflect a decrease from 1958. As of Jan. 1, 1960, the GGS estimated reserves at 517,800,000 barrels, as compared with 532,500,000 barrels a year before. Of the 1960 estimate, 411,010,000 barrels were reported as proven and 106,800,000 barrels were classified as probable.

No recent estimates were available for natural gas reserves; however, this figure may amount to between 400 and 500 billion cubic feet.

Exploration. During the past year, $9 million was spent on geophysical operations. Fifty-nine crews were employed, 42 of which were seismic parties. Of the 508 wells completed in 1959, almost 67 percent were successful. Of the completed wildcats, slightly more than 21 percent encountered new oil or gas deposits as compared with 15.4 percent in 1958. However, most of the new discoveries appeared to be of minor economic value.

New discoveries. The four commercial dscoveries reported last year included:

1. Loeningen 2, located east of the Hemmelte-West oil field in the Weser-

Crude Oil and Natural Gas Production, Producing Wells, and Drilling in West Germany in 1959, by Regions

REGION	CRUDE OIL Production Total Barrels	CRUDE OIL Production Bbls. Daily	CRUDE OIL Producing Wells End 1959	NATURAL GAS Production Thous. Cu. Ft. Total	NATURAL GAS Production Thous. Cu. Ft. Daily	NATURAL GAS Producing Wells End 1959	Total Footage Drilled in 1959 (Feet)	WELLS COMPLETED IN 1959 Field and Extension Wells Oil	Gas	Dry	Total	Wildcats Oil	Gas	Dry	Total	All Wells Oil	Gas	Dry	Total	Wells Drilling at End of 1959
Schleswig-Holstein-Hamburg	3,193,445	8,749	289				178,438	17			17			1	2	18		1	19	9
Emsland	9,604,149	26,313	1,034	2,987,208	8,184	13	281,072	40	3	10	53	1	3	4	8	41	6	14	61	15
Weser-Ems	8,115,016	26,233	647	4,415,268	12,097	6	634,732	106		20	126	3	3	13	19	109	3	33	145	25
Hanover	13,244,603	36,286	1,529	554,125	1,518	5	727,389	94		36	130	3		22	25	97		58	155	26
Upper Rhine Valley	1,264,794	3,465	204	2,484,785	6,808	62	353,103	30	9	23	62	6	1	10	17	36	10	33	79	11
Alpine Foreland	807,575	2,213	42	3,174,094	8,696	16	243,651	13	6	2	21			18	18	13	6	20	39	13
Others				73,419	201		51,640							10	10			10	10	6
Total	36,229,582	99,259	3,745	13,688,899	37,504	102	2,470,025	300	18	91	409	14	7	78	99	314	25	169	508	105

WEST GERMANY

Ems oil province. This joint venture of Gewerkschaft Brigitta-Mobil Oil found oil in the sands of the Kimmeridge and the upper Dogger between 3,766 feet and 3,806 feet on a saddle structure. Initial output was 175 barrels daily of 33.5 gravity crude. Since discovery, Loeningen has been producing at a rate of 5,000 barrels monthly.

2. Buchhorst Z 1, a gas discovery between the Wehrbleck and Barenburg oil fields in the Weser-Ems area. Also jointly owned by Gewerkschaft Brigitta-Mobil Oil, this test found gas production of 5.4 MMcf per day in the main dolomite of the Zechstein between 9,950 feet and 10,055 feet.

3. Esche Z 1, a natural gas discovery located on a separate uplift of the Kalle structure near Emlichheim in the Emsland area. Drilled on a concession held by the C. Deilmann-Gewerkschaft - Elwerath - Preussag - Wintershall group, the test produced about 3.5 MMcf per day from a depth of between 9,402 and 9,590 feet.

4. Wielen Z 2, also a gas discovery west of the Itterbeck-Halle gas field in the Emsland area. Located on a concession held by the same group that drilled the Esche discovery, this wildcat discovered 3.8 MMcf per day gas production from the Zechstein at the 6,657-6,844-foot interval.

TABLE 1—Production and development drilling in Great Britain in 1959

(BP Exploration Company Limited)

Field	Crude Oil Production 1959 Total Bbls.	1959 Bbls. Daily	1958, Bbls. Daily	% Diff. in 1959	Crude Oil Producing Wells at End of 1959 Flowing	Pumping	Total	Field Wells Drilled in 1959[5] Oil	Gas	Dry	Total	Footage	Wells Drilling, End of 1959[5]
Bothamsall	57,894	159	13[1]	+1123	...	8	8	10	...	2	12	40,360	1
Caunton	7,694	21	24	−14.3	...	10	10	...	...	...	...	...	...
Corringham	16,300	45	8[1]	+462	...	2	2	1	1	1	2	15,731	1
Cousland[2]	...	...	...	...	...	...	...	...	...	...	...	1,723	1
Duke's Wood	135,683	371	435	−14.7	...	106	106	...	...	...	...	...	...
Eakring	36,483	100	139	−28.1	6	28	34	...	...	...	...	...	...
Egmanton	261,704	716	766	−6.5	...	36	36	1	...	...	7[4]	24,449	...
Formby	609	2	2	...	...	10	10	...	...	...	...	...	...
Gainsborough	9,364	26[3]	...	...	...	1	1	1	...	...	2	11,955	...
Kelham Hills	57,982	159	195	−18.5	...	41	41	...	...	...	...	...	...
Kimmeridge	18,560	51[3]	...	...	1	...	1	...	...	...	...	2,976	1
Langar	90	...	1[1]	...	...	...	...	...	...	...	...	...	...
Plungar	25,946	71	68	+ 4.4	...	8	8	1	...	2	3	6,277	...
Total	628,309	1,721	1,651	+ 4.2	7	250	257	14	1	5	26[4]	103,471	4

[1] 1958 discovery, not on production during full year. [2] Gas field in Scotland. [3] 1959 discovery. [4] Includes 6 water injection wells in Egmanton field. [5] 1959 completions and tests were as follows, by fields. Bothamsall: oil, wells 2, 3, 4, 5, 7, 8, 9, 10, 11, 16; dry, wells 6, 13; drilling, well 15. Corringham: oil, well 5; dry, well 2; drilling, well 6. Cousland: drilling, well 6. Egmanton: oil, well 57; water injection, wells 54, 55, 56, 58, 59, 60. Gainsborough: oil, well 3 (also well 1, recorded in Table 2); gas, well 2. Kimmeridge: oil, well 1 (recorded in Table 2). Plungar: oil, well 23; dry, wells 24, 25.

Great Britain . . . Dorset discovery well brightens oil outlook; offshore interest rising

THE OIL OUTLOOK in Great Britain in 1960 was brighter than it had been in several years. BP Exploration Co. Ltd brought in an oil well last year at Kimmeridge in Dorset, near the south coast, 150 miles from the nearest production in the east Midlands. The new production was found at about 1,800 feet in middle Jurassic Cornbrash limestone, and the well produced 18,560 barrels of oil last year. This is the first Jurassic production in Britain, virtually all of the previous production having been found in Carboniferous beds. Although the Kimmeridge find is probably small, it resembles the Paris Basin fields producing from the Dogger formation in France.

Encouraged by the Dorset discovery and by similar ones in the Paris Basin, BP renewed efforts to evaluate offshore prospects in southern England. In November 1959, a marine seismic survey was conducted off the southwest coast of the Isle of Wight. A continuous sedimentary basin is believed to exist under the English channel from France to southern England. An additional marine seismic survey was planned offshore from Ringstead in Dorset.

The 1959 discovery at Gainsborough in Lincolnshire in the east Midlands was also confirmed. Oil was discovered in the upper Carboniferous Namurian formation, and the well commenced commercial production last year.

Crude oil production was increased to 1,721 barrels daily in 1959, representing a 4.2 percent boost compared with the 1958 average of 1,651 barrels daily. Increased production from Bothamsall, Corringham, Gainsborough, Kimmeridge, and Plungar fields offset declines in yields from the others. Total drilling footage amounted to 135,613 feet in 1959 and 35 wells were completed, compared with 95,403 feet of hole and 27 completions in 1958. Development and exploratory drilling and production data are summarized in Tables 1 and 2.

Four wells were being drilled at the end of 1959. Drilling rates continued to rise during the first six months of 1960. BP completed 18 wells during this period, and expected to complete 22 more during the last half for a total of 40 this year.

Pipe line. Late in 1959 BP announced completion of Britain's longest pipe line, to move imported crude 60 miles across South Wales from a tanker terminal being built near Angle Bay, Milford Haven to the Llandarcy refinery, near Swansea. The 18-inch line will have a capacity of 100,000 barrels of crude daily. Continuous expansion of refining facilities is required in Britain since petroleum demand exceeds 650,000 bpd and continues to rise.

TABLE 2—Exploratory wells drilled in Great Britain in 1959

(All BP Exploration Co. Ltd. except for well No. 3 below)

Name of Wildcat Well Location or Locality	No. Wells Completed in 1959	Total Depth (feet) and Results[8]
1. Bere Regis[1]	1	5,533 dry
2. Bingham	1	2,954 dry[2]
3. Fletcher Bank[3]	1	5,515 dry[4]
4. Gainsborough[5]	1	5,706 oil[6]
5. High Marnham	1	3,800 dry
6. Kimmeridge[5]	1	1,816 oil[7]
7. Langton Herring	1	1,400 dry
8. Langton Herring North	1	1,305 dry
9. Walkeringham	1	6,390 dry

[1] Winchester 1 wildcat being drilled in Bere Regis vicinity at end of 1959. [2] Oil show in lower Carboniferous. [3] Drilled by Steel Brothers and Co. Ltd. [4] Bottomed in shale below Millstone grits. [5] Well and footage excluded from Table 1. [6] Oil in upper Carboniferous (Namurian). [7] Oil in middle Jurassic (Cornbrash). [8] Total exploratory footage drilled in 1959 was 32,142 feet. Sum of development and exploratory footage in 1959 was 135,613 feet.

Greece . . . Esso has signed new agreement

No drilling or geophysical activity was reported in Greece in 1959. However, in December Esso Hellenic, Inc., signed an agreement under the new Greek oil law, granting it exploration and development rights to a 1,544-square-mile area near the islands of Paxi and Zakynthos, off the southwestern coast and in western Peloponnesia.

In 1960, exploration permits were granted to Helios S.A., and Hunt International. The French agency Regie Autonome des Petroles (RAP), will supervise exploratory work for Helios in Thrace. At least three deep wells are to be drilled in this area by 1964, with the first 10,000-foot test scheduled for April 1961.

Hunt International's permit covers 1,544 square miles in the Salonika-Katerini area, and is subject to approval by parliament.

On July 14, 1960, The British Petroleum Co. Ltd. announced signing of an agreement for oil exploration rights on 2,200 square miles in Aetolia-Akarnania and Lefkas and Cephalonia islands in western Greece, in partnership wth the National Bank of Greece. Geological work was to commence soon.

Italy . . . important gas field is discovered

Exploratory emphasis shifted in 1959 and 1960 from the Po Valley to east-central and southern Italy. A primary reason was the discovery and development of an important natural gas field at Ferrandina in the Bradano trough west of Puglia. Also AGIP Mineraria and other operators were legally obligated to complete some exploratory work on certain permits outside of the Po Valley.

In addition, exploration was being pursued actively in the southern Alpine region, in the northern Apennines, along the Adriatic Sea coast, and in the Tremiti Islands. In July 1960 AGIP Mineraria was reported drilling an offshore test in the Adriatic Sea near Ravenna. Some positive results were being obtained, notably in the Bradano trough; in some other regions, a number of permits were considered condemned by deep dry holes completed last year.

New gas areas. The newly-enhanced gas area in Puglia is located in extreme southeastern Italy. The Ferrandina-Grottole gas field found in 1959 produces from Cretaceous limestone and from Pliocene-Quaternary sand lenses from 2,000 to 2,800 feet of depth. Reserves were estimated at 300 billion cubic feet. Following completion of the Ferrandina find and of extensions at Grottole, a new field was found under similar geological conditions last year at Pomarico, 6¼ miles southeast of Ferrandina.

Farther north, the San Salvo gas field was discovered 6 miles inland from the Adriatic Coast at the south edge of the Abruzzo region. Production is from the Pliocene from 3,000 to 4,800 feet. Six gas wells had been completed at San Salvo by early 1960.

Also in the Abruzzo region, Petrosud (Montecatini interests) developed the Cellino gas field, a 1958 discovery located 19 miles northwest of Pescara, last year. About eight gas producers were completed, proving about 30 billion cubic feet of reserves. Farther north along the Adriatic Coast, the Metauro Co. found a small gas field at Fano 1, nine miles south of Pesaro in Pliocene sands at 1,800 feet.

In April 1959, AGIP Mineraria took over central and southern Italian permits formerly held by its affiliate SOMICEM. Both are subsidiaries of Ente Nazionale Idrocarburi (ENI). AGIP Mineraria had about 30 rigs running in early 1960.

In southeastern Italy, Adriatic Petroleum Corp., which combines Cities Service and Pan American International Oil Co. interests, holds 677,300 acres.

Production. Crude oil production in Italy amounted to 657,272 barrels last year, an average of 1,801 barrels daily, 369 bpd more than the 1958 daily average of 1,432 barrels. Production is from Cortemaggiore, Tramutola, Vallecupa, and Cigno fields. Condensate production amounted to 497,701 barrels, an average of 1,364 bpd, down 7.7 percent from the 1958 figure (1,478 bpd). Natural gas from the Po Valley fields continued its steady rise in 1959, amounting to 216,012 MMcf, an average of 592 MMcf daily, up 20 percent from the 1958 production. Nine gas wells were completed in 1959 in the important new Spilamberto field. Also, a promising new gas field was brought in at Sabbioncello in the Po Valley.

Drilling. There were 166 full-hole tests completed last year, aggregating 803,918 feet of hole in peninsula Italy, compared with only 121 completions and 637,990 feet in 1958. The shift from the Po Valley to other parts of peninsular Italy is strongly reflected in Table 1. In 1958, there were 96 completions and 512,556 feet of hole cut in the Po Valley; in 1959, only 66 completions and 327,341 feet of hole. Elsewhere, however, only 25 completions and 125,434 feet of hole

Table 1—Drilling in Italy in 1959

Adapted from The American Association of Petroleum Geologists *Bulletin* 44, No. 7 (1960)

Area and Company	Wells Completed in 1959										Footage Drilled (Feet)	
	Development Wells			New Pool and Outpost Tests			New Field Wildcats			Total Wls.		
	Productive	Dry	Total	Productive	Dry	Total	Productive	Dry	Total		1959	1958
Po Valley	15	14	29	3	5	8	4	25	29	66	327,341	512,556
AGIP Mineraria[1]	14	4	18	3	5	8	4	19	23	49	302,341	490,113
Other Firms[2]	1	10[3]	11	0	0	0	0	6[3]	6[3]	17	25,000	22,443
Peninsular Italy	31	21	52	5	3	8	5	35	40	100	476,577	125,434
AGIP Mineraria[1]	22	6	28	5	3	8	4	23[4]	27	63	300,113	88,434
Petrosud	8[5]	12[5]	20	..	..	..	0	11	11	31	150,300	27,000[3]
Other Firms	1[5]	3[5]	4	..	..	..	1	1	2	6	26,164	10,000[3]
Total, Italy[6]	46	35	81	8	8	16	9	60	69	166[7]	803,918[7]	637,990

[1] And affiliates. [2] Excludes shallow drilling for gas associated with salt water in Po Delta area. [3] Estimated. [4] Including a well drilled by AGIP Mineraria associated with Societa Petrolifera Italiana (S P I). [5] Including new pool and outpost tests. [6] Mainland. [7] Excludes 15 stratigraphic tests aggregating 27,427 feet of hole.

ITALY

Photo Courtesy PRAKLA

A seismic reflection crew is shown at work in Italy. Italian geology is generally very complex. Intensive coordination of geophysical and geological data is required to determine accurate locations for deep wildcats needed to probe the nation's oil and gas prospects adequately. Several important new gas fields have been found in Italy recently in the central and southeastern parts of the penisula along the Adriatic coast.

was drilled in 1958, compared with 100 completions and 476,577 feet of hole outside of the Po Valley in 1959.

Pipe lines. The 225-mile, 18-inch heated pipe line to move crude and heavy fuel oil from Genoa to Milan, Cremona, and Torino was under construction. It was to be extended 125 miles more to Aigle, Switzerland, to a new refinery to be built there.

A new pipe line network was also planned to distribute Ferrandina gas.

Refining. Thirty-five refineries in Italy had an aggregate charging capacity of almost 800,000 bpd at the end of 1959. Thruput averaged more than 500,000 bpd last year.

Luxembourg

THE MINISTERIAL COMMITTEE OF ECONOMIC COORDINATION has formulated plans for hydrocarbon exploration in the country. Approximately 20 million francs has been appropriated to finance subsurface exploration for hydrocarbons and other minerals. The program is expected to include the drilling of stratigraphic holes (From AAPG Bulletin 44, No. 7, 1960).

Mediterranean

NO EXPLORATORY WORK was reported on the island of Cyprus during 1959. Forest Oil Corporation's original exploration license, covering most of the island, was again renewed. Activity is not expected to pick up until the current political controversy is settled.

British Petroleum Exploration Co.'s Naxxar 2 on Malta, spudded in late 1958, was declared dry and abandoned in August 1959, and BP's concession was relinquished.

Netherlands...
production rises

CRUDE OIL PRODUCTION continued to rise in western Holland last year, offsetting the decline at Schoonebeek field, to provide steady rises in total output. Active exploration continued, resulting in the discovery of new gas sources. The oil search is also proceeding offshore. N V Nederlandse Aardolie Mij (NAM) was conducting a marine seismic survey during mid-1960 off the south Holland coast, and expected to drill three tests in 1961. The $1.4 million mobile drilling platform "Triton" is to be operated

Table 1—Crude Oil Production, Producing Wells, and Oil Field Drilling in The Netherlands in 1959

REGION and Field	Wells Completed in 1959					Wells Drilling, End of 1959	Oil Wells Producing at End of 1959				Producing Zone		Crude Oil Producing			
													1959			
	Footage	Oil	Gas	Dry	Total		Flowing	Pumping	Other Art. Lift	Total	Depth (feet)	Formation[1]	Total Bbls.	Bbls. Daily	BPD, Dec.	1958, Bbls. Daily
EASTERN																
Schoonebeek	12,077	2		2[2]	4[2]			278	6	284	2,500	L C ss	7,278,916	19,942	19,083	22,181
WESTERN																
IJsselmonde	33,797	2		1	3[3]	1[3]	15			15	3,100	L C ss	1,599,479	4,382	4,323	1,865
Wassenaar	26,511	4		2	6		17	1		18	4,200	L C ss	1,510,363	4,138	4,973	2,059
De Lier	32,065	5	1	1	7		6	4	10	20	5,200	L C ss	583,276	1,598	1,827	1,197
Pijnacker							4			4	5,800	L C ss	393,598	1,078	957	1,337
Rijswijk									7	7	2,500; 5,100	L C ss	371,941	1,019	812	1,500
Zoetermeer	7,976	1		1	2			7		7	3,200	L C ss	346,877	950	957	419
Ridderkerk	29,628	2		1	3[4]	1[4]	4			4	3,100; 5,000	L C ss	64,119	176	259	184
Moerkapelle	8,931	1		1	2			5		5	[5]	L C ss, J Calc. ss	36,569	100	96	46
Berkel								3		3	3,100; 3,700	L C ss	24,101	66	69	71
Meyendel											4,200	L C ss	21,422	59	32	13
Werkendam								1		1	6,500	J sts	10,969	30	31	17
Delft							1	2		3	3,100; 3,800	L C ss	9,215	25	26	31
Alblasserdam								1		1	4,800	J ss	617	2	18	4
Sub Total[6]	138,908	15	1	7	23	2	47	24	17	88			4,972,546	13,623	14,380	8,743
Total	150,985	17	1	9[2]	27[7]	2[7]	47[8]	302	23	372			12,251,462	33,565	33,463	30,924

[1] Producing horizons abbreviated as follows: L C—lower Cretaceous; J—Jurassic; calc.—calcareous; ss—sandstone; sts—siltstone. [2] Includes 2 water injection wells. [3] Excludes 4 wells suspended as of 12-31-59. [4] Excludes 2 wells suspended as of 12-31-59. [5] Moerkapelle pays are found at 2,400; 3,200; 3,800, and 4,000 feet, respectively. [6] Western Holland (i. e., outside Schoonebeek field). [7] Excludes 6 wells suspended as of 12-31-59. [8] Excludes producing wells in gas fields in Holland.

in the North Sea off Holland by NAM next year.

Gas discoveries. A commercial gas discovery was made last year by NAM at Slochteren 1 near Groningen in northeastern Holland. The discovery well was drilled to 8,536 feet. The main dolomite of the Zechstein and the underlying Rotliegend yielded 5.3 MMcf daily. A smaller gas find was made in western Holland near Rotterdam at Oude Lede 1, which bottomed at 6,127 feet. An Upper Barremian (Cretaceous) zone at 4,028 feet yielded 950,000 cubic feet daily.

Nine other wildcats were dry. Together with development drilling recorded in Table 1, the 69,678 feet of exploratory drilling provided a total of 220,663 feet of hole in 1959.

Crude oil output increased by 2,641 barrels daily or 8.5 percent to 33,565 bpd in 1959 compared to the previous year. Schoonebeek field oil production declined 10.1 percent from 22,181 bpd in 1958 to 19,942 bpd in 1959. But production from the newer western Holland fields increased 55.8 percent, from 8,743 bpd in 1958 to 13,623 bpd in 1959. Hence, Schoonebeek's portion of the total declined from 71.7 percent in 1958 to 59.4 percent in 1959.

Netherlands oil production is listed by fields in decreasing order of 1959 output in Table 1. A total of 13 fields in western Holland produced some oil last year. Most of the fields are small; however, significant reserves may be established in the IJsselmonde-Ridderkerk area east of Rotterdam.

Natural gas production amounted to 7,411,381 Mcf (20.3 MMcf daily) in 1959. Of this, 5,903,550 Mcf (16.2 MMcf daily) was produced in the eastern Netherlands; and 1,507,831 Mcf (4.1 MMcf daily) was produced in western Holland, according to The American Association of Petroleum Geologists *Bulletin* 44, No. 7 (1960). Ten gas wells were on production at the end of 1959.

NAM applied for concessions covering De Lutte and Rossum gas fields on December 1.

Four rigs were active last year, and two onshore seismic crews were utilized in addition to the marine seismograph party.

Sicily . . . discouraging drilling results lead to a decline in exploration despite increase in crude oil production

ALTHOUGH CRUDE OIL PRODUCTION increased in Sicily last year, exploratory activity was on the wane because of discouraging results during the past two years. The Gela oil field was considerably extended last year, and a new oil field was discovered north of Gela.

Small gas fields in western Sicily discovered at Mazara del Vallo and Lippone in 1958 were developed in 1959 and confirmed to be of minor size. Production was to commence in 1960. This production will augment gas output at Catania.

Production. Crude oil production in Sicily amounted to 10,704,598 barrels in 1959 (Table 1), an average of 29,328 barrels daily. This was an increase of 12.4 percent above the 1958 rate of 26,098 bpd. Gulf Italia increased output from Ragusa field by 11.5 percent from 22,929 bpd in 1958 to 25,553 bpd in 1959. There were 43 wells, all on pump, producing at Ragusa at the end of 1959, with three oil wells shut in. At Gela, production was still limited, handicapped by the low API gravity, extremely sour crude which is difficult to utilize. Production averaged 3,775 bpd last year from about 15 wells, compared with 3,178 bpd from 12 wells in 1958.

Gela crude has a hard asphalt content of 25.9 percent and sulfur content of 7.89, by weight. Maximum pay thickness at Gela is about 1,250 feet, below 10,000 feet. Deep well pumps are used, set at about 2,300 feet. To decrease crude oil viscosity, diesel oil is injected just below the deep pump via a 1-inch macaroni string in proportions of 5 to 10 percent of crude oil volume.

To place Gela on full production, ENI has been authorized by the Italian and regional Sicilian governments to build elaborate processing and petrochemical facilities. The new plant will be managed by a new entity, ANIC-Gela and will be able to process 50,000 barrels of crude daily. An associated power station will be fueled by petroleum coke. In addition to coke, the new plant will produce LPG, gasoline and light distillates, gas oil, fuel oil, ammonium sulfate, urea, propylene, polyethylene, ethanolamine, glycol, and sulfuric acid. The plant is expected to be on stream in 1963.

There is some small production of natural gas at Catania (WORLD OIL, August 15, 1959, page 154.)

Exploration. Virtually all phases of exploratory activity declined in Sicily last year compared with 1958. Gulf Italia drilled a deep test (well 45) in Ragusa field, with negative results

Portugal . . . wildcatting is continuing

DURING 1959, Mobil Exploration Portugal, Inc., carried out exploration in Portugal. Two drilling rigs were active, drilling a total of 8 wildcats. Five were in the Bombarral Basin and three in the Tejo Basin.

In the Bombarral Basin, Lourinhã 1, about 33 miles north-northwest of Lisbon, was drilling at the beginning of the year, and it was abandoned at 5,095 feet. Abaida 101, about 25 miles north of Lisbon, was abandoned at 1,476 feet. Runa 1, about 23 miles north of Lisbon, was abandoned at 1,575 feet. North Matacaes 1, 25 miles north of Lisbon, was abandoned at 4,478 feet. Praganca 1, located 31 miles north of Lisbon, was abandoned at 1,640 feet.

In the Tejo Basin, Samora 1-A, about 50 feet south of Samora 1, was abandoned at 5,938 feet. Montijo 1, approximately 10 miles east of Lisbon, was abandoned at 7,506 feet. Barreiro 2, located 6 miles southeast of Lisbon, was abandoned at 7,956 feet. The Abaida, Runa and North Matacaes wells were drilled in the same area, the first being about two miles north of the second and the second about one mile east of the third. A total of 31,770 feet was drilled last year.

SICILY

Photo Courtesy PRAKLA

This photograph shows the detonation of explosives immediately offshore in the Mediterranean Sea in southern Sicily by a seismograph crew. Exploration is continuing in Sicily, spurred by discovery and development of Ragusa and Gela, both major oil fields.

below the field pay. This well bottomed at 14,932 feet before being plugged back. Gulf drilled two dry holes and was drilling another wildcat, Margherita 1, at the end of 1959.

AGIP Mineraria extended Gela field to a total productive area of 5,500 acres at the end of 1959, compared with 3,200 at the end of 1958. Among the 14 successful field wells completed last year, two were drilled more than a mile offshore, south of the main part of the field. Gela 31, located 3 miles offshore, was drilling at the end of 1959 and was reported suspended in May 1960.

AGIP Mineraria completed an oil discovery at Cammarata last year. The well, located about 6 miles north of Gela, bottomed at 12,245 feet. About 550 feet of oil saturated oolitic limestone, evidently correlative with black shales forming the cap rock for the Triassic pay zones at Gela, was found at Cammarata.

Compagnia Idrocarburi della Sicilia D'Arcy S.p.A. (CISDA) concluded its production tests of the Vittoria well, where 6° API gravity oil was found in 1954, and dropped its Vittoria permits.

West German interests entered the Sicilian exploration picture for the first time in 1959. Preussische Bergwerks und Huetten A G acquired 230,000 acres in four permits in the Monte Pecoraro and Pizzo Cervo areas near Palermo, and the Mazzarino and Racalmuto areas near Caltanissetta north of Gela. Preussag started geophysical work and shallow drilling in 1960, and may locate its first deep test by the end of this year.

Acreage. At the end of 1959, the total area of exploration permits in force in Sicily was 3,369,890 acres, compared to 4,080,449 acres at the end of 1958.

ACKNOWLEDGMENT

The source of some of this information on Sicily is AAPG *Bulletin* 44, No. 7 (1960).

Table 1—Crude Oil Production, Producing Wells, and Drilling in Sicily in 1959, by Companies and Fields

Company, Field, and API Gravity of Oil	Production		[1]Producing Wells	Wells Completed in 1959					Wells Drilling Yr. End
	Total Barrels	Bbls. Daily		Oil	Gas	Dry	Total	Footage	
Gulf Italia[2], Ragusa, 19.4°	9,326,837	25,553	43[3]	5	...	3	8	53,500[4]	1
AGIP Mineraria[2], Gela, 7.3°	1,377,761	3,775	15	15	...	14	29	302,400	2
Other Companies	...	...	...	...	...	3	3	13,250	...
Total Sicily	10,704,598	29,328	58	20	...	20	40	369,150	3

[1] End of year; all pumping. [2] And associates. [3] Not including 3 oil wells shut in. [4] Includes 23,817 feet in Ragusa Field, and in addition 14,932 feet (Ragusa 45 deep test).

Spain . . . exploration on the upturn

SPAIN'S NEW, improved legal climate for private foreign capital is showing results in increased exploratory activity. Following adoption of Spain's new petroleum law on December 26, 1958 (WORLD OIL, August 15, 1959, page 155), supplemental regulations were published on June 27, 1959. A new Spanish investment law was adopted a month later. The Spanish government retained an 8,650,000-acre reserve in peninsular Spain and opened the remainder for competitive bidding in mid-1959. By mid-1960 sizable blocks had been awarded in northern Spain south of the Pyrenees Mountains to Phillips Petroleum Company, Standard Oil

Company (New Jersey), Richfield-Cities Service, and others.

The Ebro Basin of northern Spain has thick sediments and complicated structure, with many diapirs. The geology is thus rather similar to areas north of the Pyrenees in southern France, where Lacq and St. Marcet fields have been found.

Exploratory activity increased in 1959; nineteen wells were completed and 115,000 feet of hole was drilled, compared with 14 completions and 85,000 feet in 1958. As before, all 1959 completions were dry holes, but numerous shows were reported.

Valdebro is a joint venture backed equally by the Spanish government development agency INI and a group of U.S. independents led by General American Oil Co. of Texas, also including Tennessee Gas Transmission Corp., Lion Oil Co., Murphy Corp., and lesser interests. Valdebro has drilled more than 24 wells and 200,000 feet of hole since 1953.

Valdebro abandoned Cerro Gordo 1 near Gibraltar early in 1959 at 11,675 feet after finding oil and gas shows in formations from upper Cretaceous to Triassic. In northern Spain, Pamplona 1 was abandoned at 9,148 feet in Triassic evaporites, after minor oil shows in Eocene sediments and non-commercial gas in lower Cretaceous limestone were encountered. Retuerta 1, located 40 miles southwest of Bilbao was abandoned at 11,124 feet in Triassic after finding shows of light oil in tight lower Cretaceous and Jurassic formations. Valdebro completed two other dry holes last year, drilled 51,353 feet of hole, and did 29 crew-months of seismic work.

Ciepsa (Compañía de Investigacion y Explotaciones Petroliferas, S. A.), which combines Spanish and West German (Deilmann) interests, did 10 months of seismic work last year, and completed Spain's deepest test to date. Alda 1, in Navarra province, which was spudded in 1956, bottomed at 16,503 feet without reaching the Jurassic. Minor gas flows were found in the lower Cretaceous. Ciepsa also abandoned Trevino 3 at 10,282 feet and Alloz 1 at 10,600 feet, and drilled a total of 27,336 feet of hole last year.

Eleven new prospecting concessions have been awarded to a group in which one third interests each are held by Ciepsa, Deilmann, and Spanish Gulf Oil Co. These grants amount to 644,931 acres. Seven licenses are in Catalonia, and the other four complement the existing Vitoria concessions in northern Spain.

In the Castillo 1 wildcat, two miles south of Vitoria, gas was encountered at 8,525 feet in basal upper Cretaceous. The well had been reported drilling at 4,738 feet at the end of December.

Other operators. A total of 11 shallower holes were reported completed in 1959 by Campsa, the Spanish oil marketing company; by Iberica, a private Spanish firm in partnership with Deutsche Schachtbau und Tiefbohrgesellschaft; and Adaro, an exploration group owned by Instituto Nacional de Industria (INI).

Four wells were being drilled at the end of 1959, and drilling rates were expected to increase in 1950.

Refining. The Ohio Oil Company recently announced filing a proposal with the government under which Ohio would build a new 25,000 bpd refinery on the northern coast of Spain to process Libyan crude.

At the privately-owned 60,000 bpd Compañía Española de Petróleos refinery at Tenerife in the Canary Islands, several new units were projected, as follows: a new 50,000 bpd distillation unit; a new 15,000 bpd naphtha reformer; and a new vacuum distillation unit to charge 8,000 bpd of residual.

Spitsbergen...

exploration rights sought

AMERICAN OVERSEAS PETROLEUM LTD. was involved in negotiations with the Norwegian government early in 1960 for exploration rights in Spitsbergen. Interest in the Spitsbergen archipelago's oil possibilities is analogous to the Canadian Arctic Islands lease play, since Spitsbergen is geologically related to these islands. Pre-Cambrian and Caledonian mobile belts traverse these far northern islands, northern Greenland, and Scandinavia.

Carboniferous, Permian, Mesozoic, and Tertiary sediments lie above pre-Devonian rocks disturbed by Caledonian and older orogenies in Spitsbergen. Coal has been mined in Spitsbergen for many years from the Tertiary and Cretaceous. Some Carboniferous-age coal is found also. Despite the archipelago's location above 74° 30′ north latitude, the west coast of the main island is ice-free much of the year because of the relatively warm North Atlantic Drift (related to the Gulf Stream).

Switzerland...

promising areas found

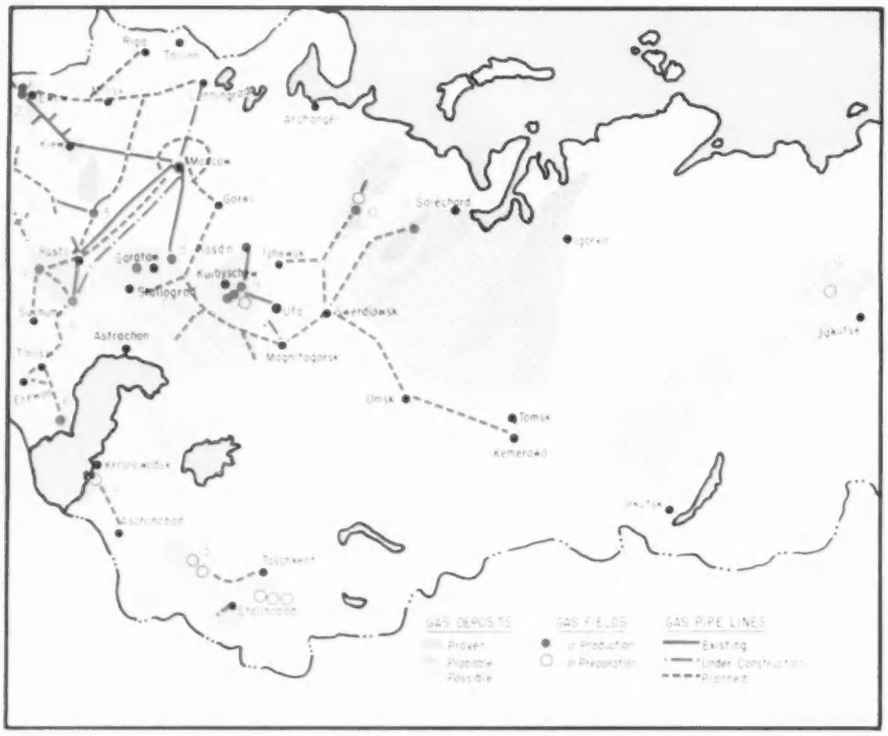
PETROLEUM INDUSTRY activity in Switzerland in 1959 was limited chiefly to seismic and gravity work. Based on extensive seismic data and surface geology, which revealed several promising structures, Schweizerisches Erdoelforschung A G spudded a test at Kusnacht, south of Zurich, in April 1960. By June 18, this well was drilling below 8,200 feet in Chattian Oligocene, not far above the main objective, the Bausteinzone sandstone of the Rupelian Oligocene. At 8,200 feet this test was already Switzerland's deepest well.

B. P. Exploration S A Fribourg, operating under a new oil and gas law passed by the Canton of Fribourg early in 1960, spudded the first test in this Canton at Courtion on June 17. This well was to test Tertiary and Mesozoic horizons down to the middle Triassic at about 8,000 feet. B P had a seismic crew working in the eastern part of its Fribourg license in mid-1960, and new drill sites were expected to be selected.

Additional exploration will be undertaken in 1960 on licenses of La Societe Anonyme de Hydrocarbure of Lausanne in Vaud and Neuchatel cantons, and Swisspetrol A G in the eastern cantons. Hydrocarbure farmed out its Vaud license to Elwerath, the West German firm. Elwerath spudded a seismic prospect at Savigny on June 1, 1960. The well was drilling below 3,280 feet on June 30.

Middleland Oil Co., which includes Swiss and minority U.S. capital, farmed out the northwest part of its Jura license to PREPA, the French firm. PREPA expected to commence a Triassic test at Mount Risoux in August 1960, on a structure which straddles the Swiss-French border.

LOCATION OF GAS DEPOSITS IN THE SOVIET UNION



Eastern Europe . . . drilling activity increases; satellite production lags

ALTHOUGH RUSSIA'S crude oil production still is roughly one-third that of the United States (2.5 million barrels per day vs. 7 million in 1959), gains are coming fast. Soviet output increased 25 percent last year—according to the country's reports.

On the other hand, Russia's seven East Europe satellites produced 273,357 barrels of crude oil per day in 1959, with many of the countries reporting production declines. Rumania continues to be the leading satellite producer, averaging 233,555 barrels per day, followed by Hungary with 21,657 barrels per day.

A rich gas deposit was reported in the center of Turkmenia's Karakum Desert, which may surpass the huge Gazli reserves in Uzbekistan. Also, discovery of a 59-foot oil horizon was reported near the Kama River in Tataria.

In the satellite countries, new oil finds were reported in the Patos and Mariz areas of Albania—Bulgaria's first Russian turbine drilling rig is operating in the country's only oil field in an effort to reach more productive horizons at 16,300 feet—and drilling programs are being stepped up in nearly every country to increase production.

Yugoslavia's crude oil production increased 28.1 percent last year, to 11,476 barrels per day. Austria's production continues its downward trend.

Russia . . . exports increase 400 percent in four years

IF RECENT REPORTS are true, the Soviet Union is now an oil power. Production surpasses demand. Crude oil and product exports have increased from 97,260 barrels per day in 1955, to 486,300 bpd last year (using a conversion factor of 7.1 barrels per metric ton).

Ninety-seven percent of satellite crude oil requirements are covered by the USSR, compared with 47.3 percent in 1950. Russian exports are crowding into several Western markets.

The 6,381-mile "TransEurope" pipe line will bring Soviet crude oil deep into the continent. Construction of two Baltic oil ports is unmistakably designed as a cheap transport base for Scandinavia and other parts of Europe.

Meanwhile, the search for more oil and gas is going on in the Soviet Union. To prospect the country thoroughly, 984 million feet of deep holes are to be drilled during the next 20 years.

Production. Last year, 2,519,000 barrels of crude oil per day (14 percent above 1958) and 3.6 billion cubic feet of gas per day (up 25 percent) were produced.

This year crude oil production is to increase 272,300 barrels to about 2,790,000 bpd and gas yield to 5.1 billion cubic feet per day. The RSFSR is to account for 90 percent of the crude increase.

Reserves. Crude oil reserves during the past decade were more than doubled. Sometimes fantastic figures crop up in Soviet literature as to reserves. Actually, no official figures are available.

The estimates of 23 billion barrels of proved, 40-55 billion barrels of probable crude oil reserves, and 35.3 trillion cubic feet of natural gas reserves remain within the range of plausibility. Last year, a record number of 18 new gas discoveries was reported.

Drilling. Total footage increased in 1959 to 25 million feet, from 23.6 million in 1958.

Eighty percent of all drilling is done with turbines. Increasing use is being made of electric and slim hole rigs. Sectional turbodrills have been improved. Their number of stages has been increased to 350.

A continuous controlled explosion drilling method has been developed. The vibration method is sporadically applied. And, according to the Russians, drilling of 16,400-foot holes no

Russia Increases Share of World Production

(Thousands of barrels per day)

Year	World Total	U. S. A. Total	U. S. A. % of World	U. S. S. R. Total	U. S. S. R. % of World
1959	19,480	7,054	36.2	2,519	12.9
1958	18,091	6,710	37.1	2,208	12.2
1956	16,733	7,151	42.7	1,630	9.7
1954	13,745	6,342	46.1	1,128	8.2
1952	12,480	6,256	50.5	924	7.5

longer raises technical problems. Drilling installations for 22,967-32,810 feet are on the drawing board or in the early stage of manufacture.

The Soviet also has announced plans to drill a 32,810-49,215-foot hole to explore the earth's crust.

Pipe lines. Last year, 1,860 miles of gas pipe lines were laid, bringing the total length to 10,557 miles.

The length of oil pipe lines to be laid this year will be 1,277 miles. By 1965, the oil pipe line network is to expand to 26,250 miles. One of the major projects is said to be a 6,381-mile "world's longest" pipe line to supply Poland, East Germany, Czechoslovakia, Hungary and other countries with crude oil from Kuybyshev.

The line's 4,347-mile eastern leg will cross much of Siberia via Omsk to Raichikhinksk near the Chinese frontier. The western leg will run from the new Tuimaza oil fields into White Russia. There, the main line will fork.

A northern branch will serve refineries now being built at Plock on the Vistula River in Poland and at the Schwert on the Oder River in East Germany. A southern branch will link up with the existing pipe line serving Rumania, Hungary, and Czechoslovakia.

Each Communist country will finance, build, and own its own section of the pipe line. Russia will provide the engineering and over-all management.

A survey of Soviet republics shows the following developments:

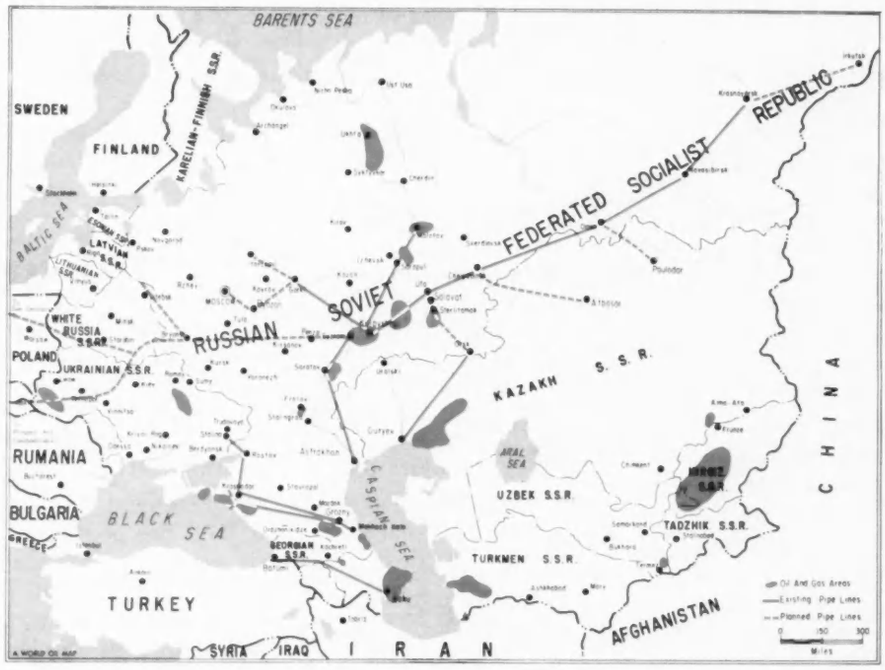
Azerbbaijan. Crude production in 1959, average 326,800 bpd. An increase of 15,000 bpd is planned for 1960. Gas yield, which averaged 500 million cubic feet per day in 1959, is to increase by 135 million this year.

The Soviet drilling program was fulfilled last year in only 5 of the 33 fields. Drilling costs are high.

During 1960, 3.28 million feet of hole are to be drilled, compared with 3.06 million feet in 1959. Directional bore holes discovered under Ali Bairamli village, Shirvan Steppe, rich oil deposits which are likely to take second place in production after "Neftyanye Kamni" offshore field in the Caspian Sea.

At Baku, an electric drill was reported to have reached the record depth of 12,304 feet. Below 9,840 feet, this drill had a 4.3 feet per hour faster drilling progress than a turbodrill in a similar geological formation At Kirovadag, difficult twin holes were drilled to 18,045 feet. One hole was vertical; the other, five feet away, was directional.

MAJOR OIL AND GAS AREAS IN THE SOVIET UNION



Bashkiria. Thirteen oil and gas fields were discovered last year. Oil finds were reported from Kumertau, Kantsbur, Meleus and Kunakbayevo. An attempt was made to store crude oil in a washed-out salt layer.

Tataria. The discovery of a 59-foot thick oil horizon in Devonian was reported in January 1959, from Zainsk, near the Kama River. Another oil deposit was discovered this June in the Melekess depression, at 6,560 feet. Equipping of the wells with automatic controls is in full progress.

This republic yields the cheapest oil in the USSR.

RSFSR. In the Kokhan oil field, near Kuybyshev, four oil bearing horizons were discovered below 9,840 feet. An oil seepage in the Khashma River valley led to the discovery of the second oil deposit on Kamchatka Peninsula. At Parfenivka, Irkutsk area, a gas discovery at 7,960 feet is believed to show promise.

Uzbekistan. The center of the oil and gas industry is shifting from Ferhana valley to Bukhara. By 1965, the republic is expected to take third place in the USSR's oil and gas production, at which time its share of the nation's total is to have increased from 22 percent to 76 percent.

During 1959-1965, 2,000 holes and 13 million feet are to be drilled.

Turkmenia. At Darvasin, in the center of the Karakum Desert, a rich gas deposit was discovered which, some experts believe, surpasses even the Gazli deposit in Uzbekistan.

The first offshore well on the eastern coast of the Caspian Sea began drilling in January 1960, off Chelekan Peninsula. Commercial exploitation of the Kotur-Tepe field was started. Oil discoveries were reported from the southwestern part of the republic.

Ukraine. Twelve oil and gas fields were discovered during 1958 and 1959. By 1965, the republic is to produce 116,700 barrels of crude and 3 billion cubic feet of gas per day.

Albania . . . several new oil fields reported

PLAN FULFILLMENT reports, issued regularly in Communist countries, are often more informative as to what

ALBANIA

they conceal than what they disclose.

The country's crude oil production curve had been climbing steadily until 1957, when it suddenly turned downward. Output figures, formerly reported with much fanfare, were dropped from last year's report. Somewhat later it was said that crude production was 19 percent higher than in 1958. This would make 8,770 barrels per day in 1959.

The latest report from Tirana said that because of the development of new oil fields in the Fieri and Valona areas, the target of the crude production plan for this year has again been set at the original level of 36,560 barrels per day.

Using 24 Russian rigs, some 160,000 feet of hole were drilled in 1959, and, for the first time, 9,000-foot wells were completed. New oil finds were reported from the Patos and Mariz areas.

Albanian Crude Production Has Doubled in Five Years

Year	Total Barrels	Bbls. Daily	Year	Total Barrels	Bbls. Daily
1938	880,704	2,413	1955	1,694,688	4,643
1947	760,608	2,084	1956	1,934,880	5,287
1948	600,480	1,641	1957	3,267,712	8,953
1950	880,704	2,413	1958	2,690,130	7,370
1953	1,334,400	3,656	1959	3,201,050	8,770
1954	1,567,920	4,296			

Bulgaria . . . rig operating in only field

BULGARIA APPEARS to be recovering from a setback in crude oil production. For the second consecutive year no production figure has been published.

The latest figure—5,205 barrels per day—was given for 1957. For the first quarter of 1960, a crude oil output figure of 860 barrels daily was mentioned. This would result in an approximate figure of 3,435 barrels per day for 1960, down considerably from 1957.

The country's leadership seems determined to mend the situation. After completion of the Geological Institute at the Academy of Sciences, the keenly felt shortage of geologists is hoped to cease.

Bulgaria's first Russian turbine drilling rig is operating in the country's only oil field at Tyulenovo. It is to reach the field's more productive horizons which, according to the Soviets, are lying at a depth of 16,300 feet. At present, the pay zone lies between 1,180 feet and 1,312 feet.

Czechoslovakia

CZECHOSLOVAKIA'S crude oil production increased 16 percent, to 2,285 barrels daily during 1959. This is the first sharp increase after an almost level production around 2,000 barrels per day in the 1955-1958 period.

No figure was released for last year's gas yield. This has been interpreted in Austria as an admission that Czechoslovakia is exploiting at a forced rate the Zwerndorf gas field, of which only one-sixth is in Czechoslovakia, the rest in Austria.

Prior to 1959, production figures showed a steep increase, from 4.29 billion cubic feet in 1955, to 40.1 billion in 1958. The latter amount was greater by 11.1 billion cubic feet than Austria's production in 1958.

To avoid excessive extraction from the border field in the future, an agreement was signed for a joint fixing of production quotas.

Exploration is concentrating on Eastern Slovakia, chiefly around Senec and Bernolakova, southwestern Slovakia and southern Moravia.

In mid-1959, ten wells were reported drilling in Eastern Slovakia, of which two were deep holes. A well was completed in January 1959, at Michalovce.

Available drilling installations are antiquated, resulting in high drilling costs and permanent non-fulfillment of the drilling program.

East Germany

. . . exploration planned

East Germans plan to drill 165 exploratory wells in 10 prospective areas during 1960. Hopes are that this effort will boost the country's crude production to 3,973 barrels daily and gas production to 5.8 million cubic feet per day by the end of the year.

At present, crude oil output is almost nil, with only 89 barrels per day being produced in 1958.

Drilling for oil and gas in the Soviet zone of Germany started nine years ago. The first traces of oil were found at Schwerin; later, at Ludwigslust, a well came in at 6,070 feet.

Since May 1957, a field at Halberstadt has been producing from 5,250 feet. However, the most productive well is said to be at Ludwigslust.

Soviet rigs have been reported in operation in Mecklenburg, where Russian specialists have joined German seismic and geological crews for six months.

Hungary . . . active program under way

CRUDE OIL production is again on the increase in Hungary, after dropping sharply from the pre-uprising level of 33,467 barrels per day.

Last year, production averaged 21,657 bpd, up 25 percent from 1958. According to plan, production will average 24,042 barrels per day in 1960.

Oil reserves are estimated at 84 million barrels. Current consumption is 41,800 barrels per day, covered half by domestic resources and half by imports. Natural gas reserves are estimated at 318 million cubic feet.

Drilling. Total footage drilled in 1959 was 1,197,565 feet, of which 328,100 feet were drilled in the Great Plain, 869,465 feet in Transdanubia.

Nine seismic crews have been surveying areas on the left bank of the Danube River, between Danube and Tisza, and around Nagykoros.

Soviet technicians tested the performance of turbodrills with French diamond bits last year. During 1960, 164,050 feet of hole are to be drilled with turbodrills.

Crude Oil Production in Hungary Approaches Pre-Uprising Levels

Year	Total Barrels	Bbls. Daily	Year	Total Barrels	Bbls. Daily
1937	19,403	53	1949	3,792,110	10,389
1938	326,541	895	1950	3,906,560	10,703
1939	1,097,125	3,005			
1940	1,910,682	5,220	1951	3,807,370	10,431
			1952	4,562,740	12,664
1941	3,220,913	8,824	1953	6,454,980	17,685
1942	5,078,765	13,914	1954	8,530,340	23,370
1943	6,393,940	17,517	1955	12,215,630	33,467
1944	6,181,460	16,889			
1945	5,003,579	13,708	1956[2]	9,172,397	25,061
			1957[3]	5,127,360	14,047
1946	5,148,510	14,105	1958	6,325,270	17,329
1947	4,346,300	11,908	1959	7 905,000	21,657
1948[1]	3,685,290	10,069	1960[4]	8,775,695	24,042

[1] Oil industry nationalized. [2] Water encroachment at Nagylengyel. [3] After effect of October, 1956, uprising [4] Planned production.

OIL AND GAS FIELDS IN POLAND

Center of production is in southeastern corner of country. Number of producing oil wells is 3,000; area of producing oil fields is 7.3 square miles.

Poland . . . decline of production continues

WITH THEIR fingers pointed to the latest discoveries of oil and gas, Polish leaders are trying to overcome the regime's sluggishness in matters of exploration. Lack of finances seems to be a major obstacle.

Crude oil output averaged 3,555 barrels per day in 1959, down only slightly from 1958. However, the downward trend since 1956 cannot be overlooked.

Natural gas production averaged 41 million cubic feet per day last year, or 7.5 million cubic feet over 1958—but still 1.4 million per day short of the post-war high in 1957.

Crude oil production covers only 10 percent of the need. Chief supplier is the Soviet Union, which has delivered 67 million barrels of crude and products in the past 15 years.

Drilling. Footage drilled for exploration and development was 416,687 feet during 1959. Experts say that to make progress in developing the country's oil and gas potential, it will be necessary to drill at least 2,460,000 feet per year for exploration alone.

New field. Commercial production of the Mielec oil field was started in June 1959, with two wells producing 89 barrels per day each.

Gas yield covers about 65 percent of the need. After completion of the 77-mile Lubaczow-Rzeszow-Sedziszow gas pipe line, commercial production of the new Lubaczow-Uszkowce field will be started with 9 wells this year.

Trends in Oil and Gas Production in Poland

Year	Wells	CRUDE OIL PRODUCTION		NATURAL GAS PRODUCTION	
		Total Barrels	Bbls. Daily	Total Million Cu. Ft.	Million Cu. Ft. Daily
1949	3,220	1,123,237	3,077	5,438	14.9
1955	3,500	1,333,936	3,655	4,785	13.1
1956	3,549	1,362,774	3,723	13,887	37.9
1957	n.a.	1,340,547	3,673	15,376	42.1
1958	n.a.	1,298,325	3,557	12,240	33.5
1959	n.a.	1,297,575	3,555	14,965	41

Rumania . . . oil operations are lagging

WHAT WESTERN experts have been conjecturing for some time is being confirmed with each successive year: Rumania's crude oil production is stagnating.

Output in 1959, increased only 1 percent over 1958, to 233,555 barrels per day; 1957-1958: up 1.4 percent, while natural gas yield increased 14 percent to 559 million cubic feet per day; 1956-1957: up 9.6 percent.

The trend was further highlighted by the just published draft plan for 1960-1965, which provides for crude oil production to average 249,114 barrels daily—26,914 less than the 1956-1960 plan.

However, gas production is to increase 2.3 times to 1.28 billion cubic feet per day in 1965.

The performance in production of equipment outpaced the oil and gas effort. The 72 drilling units manufactured last year represented a 47 percent increase over 1958. In 1965, Rumania expects to be manufacturing 135-140 rigs.

Drilling. The modest result in the oil producing sector of the industry is worrying the country's leaders. As a first step toward improvement, a Geological Institute was set up this year to carry out scientific research and issue geological maps.

Yugoslavia . . . crude output up sharply

YUGOSLAVIA'S CRUDE oil production averaged 11,476 barrels per day last year, up 28.1 percent from the 8,949 bpd of 1958.

Encouraged by this upward trend, plus the promising results achieved in prospecting work, planners in Belgrade are confident that crude oil imports will cease by 1961. Oil reserves in tested areas are estimated at more than 105 million barrels.

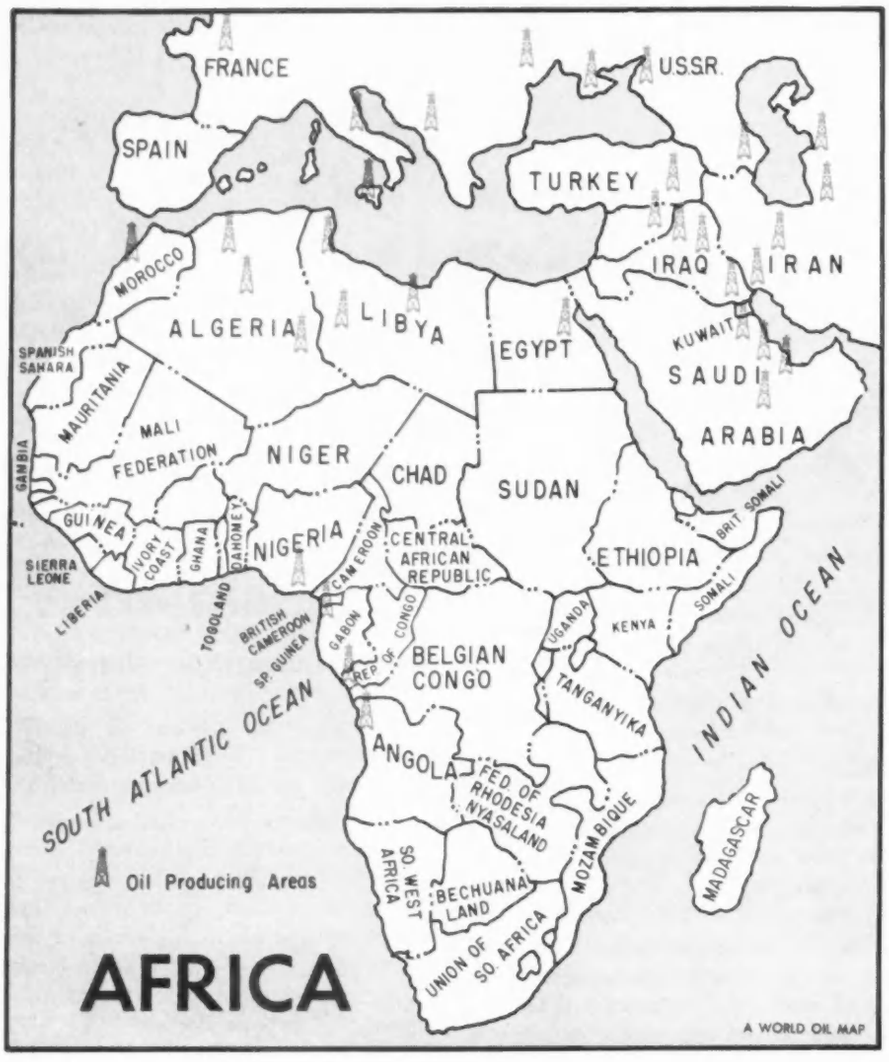
Geologists consider the areas north of the Danube River and along the Adriatic coast as the most promising.

Drilling. President Tito was present last May when Yugoslavia's first pipe line and richest oil field (Struzec) were put into operation. The new line links the field with Sisak refinery and Sava River port, 10.5 miles to the south. Estimated reserves of the Struzec field (Croatia) vary between 70 and 110 milion barrels.

Of the $9.3 million allocated for prospecting work during 1959, the greater part was spent on defining limits of the fields at Struzec-Osekovo; at Ferdinandovac, near Koprivnica (Croatia); at Elemir (Banat); and at Kikinda (Voivodina).

Yugoslavia's Crude Output Almost Tripled in Five Years

Year	Total Barrels	Bbls. Daily	Year	Total Barrels	Bbls. Daily
1939	7,700	21	1954	1,529,008	4,189
1949	447,107	1,225	1955	1,818,432	4,982
1950	777,700	2,131	1956	2,076,318	5,673
1951	1,047,300	2,869	1957	2,791,943	7,649
1952	1,071,367	2,927	1958	3,266,340	8,949
1953	1,216,577	3,333	1959	4,188,740	11,476



Exploration tempo stepped up on African continent

THE AFRICAN CONTINENT is undergoing its most rapid oil search in history. At the same time many former colonies are becoming independent nations.

Major reserves of both oil and natural gas have been proved in recent years in the Algerian Sahara. With the completion of a 24-inch crude oil pipe line to the Mediterranean, Hassi-Messaoud field has gone on full-scale production. A second 24-inch line is to allow the eastern Algeria oil fields, Edjele, Tiguentourine, and Zarzaitine to start production soon. And a 24-inch gas line was proposed to tap vast reserves at Hassi R'Mel field.

In Libya, major oil reserves continue to be found and pipe line projects were underway to provide commercial outlets as early as 1962. The Western Desert portion of the Egyptian region of the UAR was opened to bids by private firms in mid-1960.

In the hope of finding oil and gas fields similar to Algeria's and Libya's, many companies commenced the search for oil in the Spanish Sahara, the geology of which was only very slightly known prior to 1959.

Nigeria and Gabon are becoming important oil-producing countries. Nigeria's production is to be strongly boosted during the next few years. Oil production from the Congo started in 1960, and Angola has been an oil producing region for several years. Recent completions have indicated possible oil production in Senegal and Cameroon. The search for oil continues in East Africa.

Oil exploration was active in a number of newly-independent members of the French community, including the Mali Federation composed of Senegal and the formerly French Sudan, in Mauritania, Dahomey, Ivory Coast, and Cameroon. The oil search continued in Portuguese Guinea and drilling was to start this fall. One oil well had been completed in Senegal and one in Cameroon, and further testing was being awaited.

Nigeria has become an important oil producing country, and significant reserves have been proven. Production of as much as 100,000 barrels daily by the middle 60's was foreseen.

North Africa

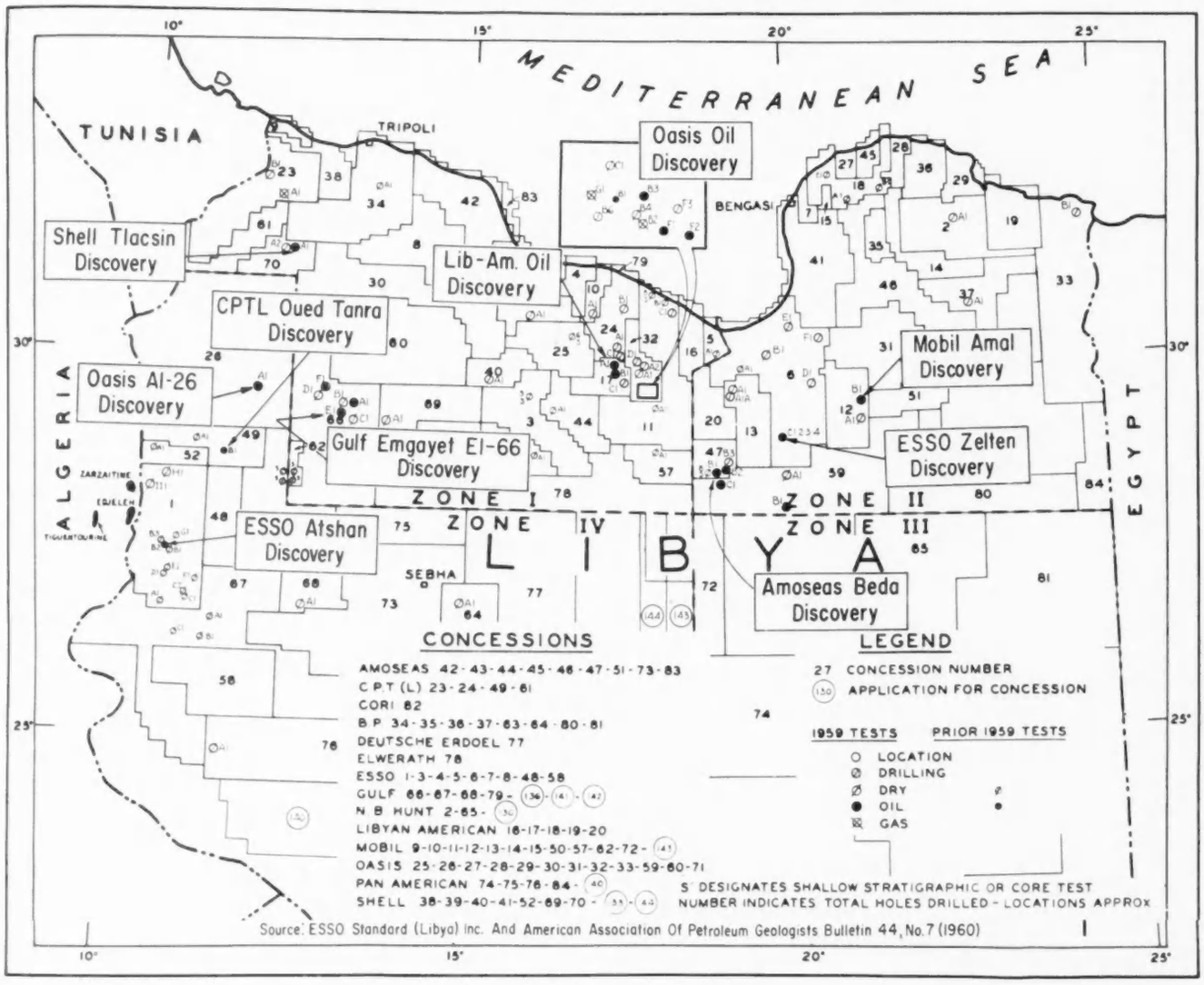
major oil reserves being proved in Libya; Algeria gets pipe line outlet

MAJOR CRUDE OIL RESERVES were being proved in Libya, both in the Cretaceous-Paleocene basin near the Gulf of Sirte in the east, and in Paleozoic basins in the west. Major pipe line projects were under way to place several Libyan fields on production, perhaps as early as 1962. In Algeria, a 24-inch pipe line between the huge Hassi-Messaoud oil field and the Mediterranean was in service, and another was to be completed late this year to link eastern Algerian oil fields with the Tunisian port of La Skirra. New drilling records were anticipated in both Libya and Algeria this year.

In the Spanish Sahara, stratigraphic drilling was to be under way by the end of this summer. Vigorous exploration was to determine soon whether the Spanish Sahara has oil possibilities similar to Libya's, or whether it is of little petroleum interest.

Morocco's crude oil production increased in 1959 for the first time in several years.

OIL AND GAS DISCOVERIES AND CONCESSIONS IN LIBYA



Libya . . . big oil fields found in both eastern and western regions; drilling booms

LIBYA is well on its way to becoming an important oil-producing country. Major reserves of oil and gas continue to be developed. At least one large pipe line and marine terminal project is underway, and commencement of commercial oil production by early 1962 is likely. Major oil fields have been proven at Zelten, Bahi-Dahra and Mabruk near the Gulf of Sirte. An important producing trend has been established by Gulf Oil Company of Libya in extreme southwestern Tripolitania (Block 66), thus proving prolific production in two of Libya's geological provinces.

In 1959 eleven companies were drilling in Libya, cutting a total of 343,321 feet of hole. There were 43 completions in 1959, and 28 wells were being drilled at the end of December. On April 1, 1960, there were 32 active rigs, and a total of 121 wells had been spudded in the nation up to that time. A total of 542,287 feet of hole had been drilled as of the end of 1959.

In 1960, at least 600,000 feet of hole is expected to be drilled, involving perhaps 100 completions. Since the Libyan petroleum law of 1955 requires concessionnaires to drop 25 percent of their holdings after five years, wildcat drilling activity is approaching a climax, and development drilling to delineate prolific new oil and gas fields is increasing in tempo also. The more significant discoveries and extension wells are summarized in Table 1. A more detailed discussion of the larger fields and trends follows.

Zelten field. The most spectacular individual discovery as of mid-1960 was made at Esso Standard (Libya) Inc. Zelten C1 on Block 6 in Cyrenaica, 100 miles inland from the Gulf of Sirte (Mediterranean) coast and 200 miles south of Benghazi. This well was completed flowing at the rate of 17,500 barrels of 37° API gravity crude from a Paleocene calcarenite limestone from 5,460 to 5,665 feet in mid-1959. Esso Zelten C2, about a four-mile stepout from the discovery, was completed in August 1959 for 15,000 bpd of 39° API gravity crude from about 5,800 feet. The confirmation test was reported structurally

lower on the pay, but still made an excellent well. Zelten C3 was completed in December 1959 for 1,600 bpd of 38.5° API gravity crude after reaching total depth of 7,850 feet. A new pay was established in the Cretaceous at about 7,100 feet. Zelten C4 was completed on December 30 for 2,500 bpd of 39° API gravity crude. Total depth was 5,924 feet.

The Zelten trend may have been extended significantly southward by Oasis Oil Company of Libya on its block 59 concession. Well B1 found a thick section of oil- and gas-bearing limestone. As of March 1959, a number of tests indicated that this well may be one of Oasis' more prolific discoveries. An additional rig was being moved by Oasis to this block to augment work by the existing one to evaluate this find.

In January 1960 Esso announced ordering 100 miles of 30-inch line pipe, and by mid-1960 had landed some of it at Marsa El Brega on the Gulf of Sirte. The crude oil line will move Zelten crude 100 miles to Marsa El Brega where a marine loading terminal is to be built. Esso is also expected to build a small refinery at Marsa El Brega to fulfill Libya's domestic products needs. It was understood that the gathering and transmission systems would be highly automated and directed essentially from Marsa El Brega to avoid the need to develop extensive facilities at the remote Zelten inland location.

Bahi-Dahra fields. Oasis Oil Company's first discovery, Bahi 1 on Block 32 in eastern Tripolitania about 80 miles inland from the Gulf of Sirte, was completed in mid-1958 pumping 800 barrels daily of 39° API gravity crude from a Cretaceous sandstone between 5,822 and 5,854 feet. The second discovery was on the same block, about 27 miles south and slightly east of the first, at Dahra 1. The Dahra well was completed on a separate closure late in 1958. There were three pay zones. The main oil zone was between 3,747 and 3,820 feet. Tests indicated this interval to be capable of yielding 1,000 bpd of 36° API gravity oil on pump. Another oil zone, from 2,750 to 2,800 feet, produced 125 bpd of 46° API gravity oil and 1 MMcf of gas daily. The third zone, at 3,100-3,300 feet, produced gas only in flows up to 2.6 MMcf daily.

As of March 23, 1960, five oil wells and 2 gas wells had been drilled at Dahra and 2 tests were drilling. Step-outs had covered an area 10 miles north-south and 15 miles east-west. The original Dahra oil zone covers a large area. The Dahra gas zone is oil-bearing on the east flank of the structure. Tests of this zone (at Oasis F-2-32) were as high as 8,000 bpd of 38.5° API gravity crude. This zone thins toward the south boundary of Block 32. Large gas reserves are also indicated.

Amal field. Mobil Oil of Canada Ltd completed Amal 1, the easternmost discovery in Libya as of mid-1960, for 990 bpd of 34° API gravity crude from 9,835-10,406 feet. Although Amal did not appear at the time to be more important (reserves-wise) than Amoseas' Beda field (Table 1), Amal was very significant in that production is from Paleozoic sandstone. Though subsurface correlations across the enormous Sahara area are rather vague at this time, it appears possible that this sandstone may be correlative to Cambro-Ordovician sandstones productive at Hassi-Messaoud field and also in the Edjele-Tiguentourine area in Algeria.

Mabruk field. Libyan-American Oil Company has completed three wells (Table 1) in Block 17 in Tripolitania west of Bahi-Dahra. These wells were believed to be in the same field. An upper oil zone was productive in all three wells between 3,000 and 3,700 feet. This zone was estimated to cover 65,000 acres. Net pay thickness is 70 feet. The lower zone, found in the first well only, contains 140 feet of net pay and covers an estimated 25,000 acres. API gravities vary from 36° to 40°; the crude is sweet. Assuming a primary recovery factor of 200 barrels per acre foot, reserves might amount to 980 million barrels at Mabruk.

In January 1960 Esso Sirte, Inc., acquired half interest in blocks 16, 17, and 20 from Libyan-American. Esso will be the operator of wells in block 17.

The Libyan government will encourage operators to build common-carrier type pipe lines wherever possible, to avoid lessening its 50 percent

TABLE 1—Discovery wells and some important extensions in Libya, 1958 through early 1960

[1]Operator	Name of Well	Concession Bl. No.	[2]Zone	Completed (Mo., Yr.)	[3]Initial Potential	Oil Gravity (deg. API)	Productive Interval or Depth (Feet)	[6]Age and Lithology of Pay(s)	Total Depth (Feet)	[7]Remarks
Esso (Libya)	Atshan 2	1	4	1-58	500 bpd	45	2,100-2,136	Devonian ss	2,960	1st Libyan find
Esso (Libya)	In Azuaza H1	1	4	4-59	4 mmcf			Silurian	8,668	
Esso (Libya)	Zelten C1	6	2	6-59	17,500 bpd	37	5,460-5,665	Paleocene calc. ls.	5,676	[7]281 ft.
Esso (Libya)	Zelten C3	6	2	12-59	1,600 bpd	38.5	7,300	Cretaceous	7,850	New pay
Oasis	Bahi 1	32	1	6-58	[4]800 bpd	39	5,822-5,864	Cretaceous ss.	6,100	
Oasis	Dahra B1	32	1	10-58	[4]1,000 bpd	36	3,747-3,820	Cretaceous ls.		
Oasis	B1	59	2	1960	Oil well			ls.		May extend Zelten S.
Oasis	A1	26	4	1960	[5]475 bpd	40	5,700-5,740	Mississippian ss.		
Lib.-Am.	Al Mabruk	17	1	7-59	600 bpd	40	3,000-3,700; 5,700		5,800	
Lib.-Am.	B1 Zahaligh	17	1	11-59	900 bpd	35	3,000-3,700		9,228	
Lib.-Am.	C1 Bu Stefa	17	1	1960	Oil well		3,000-3,700			
Mobil	Amal 1	12	2	11-59	990 bpd	34	9,835-10,406	Amal fmtion (Paleozoic ss)	11,290	E'most Libyan discovery
Mobil	Hofra 2	11	1	5-60	1,500 bpd	43	3,030			Extends Oasis' Dahra prod. S.
Amoseas	Beda 1	47	2	9-59	3,650 bpd	36.6	4,100	Paleocene calc. ls.	5,107	
Gulf	Emgayet A1	66	1	9-59	876 bpd	37.9	4,080-4,100	Devonian ss.	7,735	In basement at TD
Gulf	E1	66	1	12-59	Oil well		5,064	Devonian ss.		
Gulf	F1	66	1	5-60	1,000 bpd	39	5,160	Devonian ss.		21 mi. nw of E1
Shell	Tlacsin A1	70	1	2-59	700 bpd	44	8,900	Devonian ss.	13,187	
CPT(L)	B1	49	4	12-58	100 bpd		4,600	Carboniferous	7,595	
CPT(L)	A1	23	1	7-59	10 mmcf			Triassic	7,300	

[1] Full company names as follows: Esso Libya—Esso Standard (Libya) Inc.; Oasis—Oasis Oil Company of Libya; Lib.-Am.-Libyan American Oil Company; Mobil—Mobil Oil of Canada Ltd; Amoseas—American Overseas Petroleum Ltd.; Gulf—Gulf Oil Company of Libya; Shell—Libya Shell N V; CPT (L)—Compagnie des Petroles Total (Libye).
[2] Zones: 1—Tripolitania; 2—Cyrenaica north of 28th parallel; 3—the rest of Cyrenaica; 4—Fezzan. [3] Initial potential: oil in barrels per day (bpd); gas in million cubic feet per day (mmcf/day).
[4] Pumping. [5] Also 1.3 mmcf/day. [6] ss—sandstone; calc. ls.—Calcarenite limestone. [7] Additional data from side-tracked hole.

share of any profits. However, since Libya is a politically fragile alliance of several provincial governments, operating companies will hesitate to build "interstate" pipe lines, straddling, for example, Tripolitania and Cyrenaica.

Western Libyan discoveries. Oasis made an important discovery on Block 26 in Fezzan when well A1 tested oil and gas in Mississippian sandstone from 5,700 to 5,740 feet. Completion was in early 1960 for 475 bpd of 40° API oil and 1.3 MMcf daily.

Gulf has established a 35-mile Devonian sandstone oil-producing trend on Block 66 in extreme southwest Tripolitania (Table 1).

Basins in Libya. Cambrian and Ordovician sandstones and quartzites cover most of Libya. Western Libya is divided into two distinct basins, the Gadames (on the northwest) and Mourzouk (southwest), both containing Paleozoic sediments primarily.

Libya is geologically divided by a north-south Silurian trend from Tibesti thru Gargaf to Garian. East of this trend some early Paleozoic sediments are present, particularly in the Kufra Basin. Eastern Libya's main area of interest is the Cretaceous-Paleocene basin near the Gulf of Sirte.

Concessions. Five new concessions were granted in 1959, being numbers 78 thru 82, aggregating 28,147,617 acres. Three additional grants, numbers 83 thru 85, representing a total of 10,871,064 acres, were made early in 1960. Libya Shell N V and Pan American International Oil Corp. dropped 3,446,605 acres last year, and Esso relinquished 3,446,605 acres early in 1960.

New company. In mid-1960, a new Oasis Oil Company of Libya, Inc. was formed to provide greater participation by Continental Oil Company and Amerada Petroleum Corporation, in addition to The Ohio Oil Company. Oasis was formerly a subsidiary of Ohio, staffed by Ohio personnel. Greater effort and expenditures are needed since the development stage of the operation has been reached.

Tunisia . . . success in adjoining areas spurs interest

ACTIVITY SEEMED SURE to pick up in Tunisia in the future despite negative results of previous exploration, since the outlook is so bright in both Libya and Algeria.

Societe de Recherches et d'Exploitation des Petroles en Tunisie (SEREPT) continued to produce the small Cap Bon gas field in the extreme northeastern part of the country. Production last year was 223,341,101 cubic feet, an average of 611,893 cf daily.

Exploratory activity was centered in southern Tunisia, with five dry holes being finished by SEREPT last year. The deepest was MG 1, completed at 12,336 feet. This location was on the Libyan border about 83 miles north of Gadames. SEREPT drilled 23,032 feet of hole last year, according to *Petrole Informations*. Two of these dry holes were spudded in 1958. No rigs were drilling at the end of 1959.

SEREPT expected to conduct 30 crew-months of reflection seismic work this year, stressing extreme southern Tunisia. Deep drilling was to continue there.

In December 1959, Mobil Oil Company joined SEREPT in a partnership in exploring its concessions. SEREPT will remain the operator. Conorada Petroleum Corporation and S O M-Rimrock have started their oil search with field geology and seismic work. There were 24 party-months of seismic work by SEREPT and 3 by Conorada last year, according to AAPG *Bulletin* 44, No. 7 (1960).

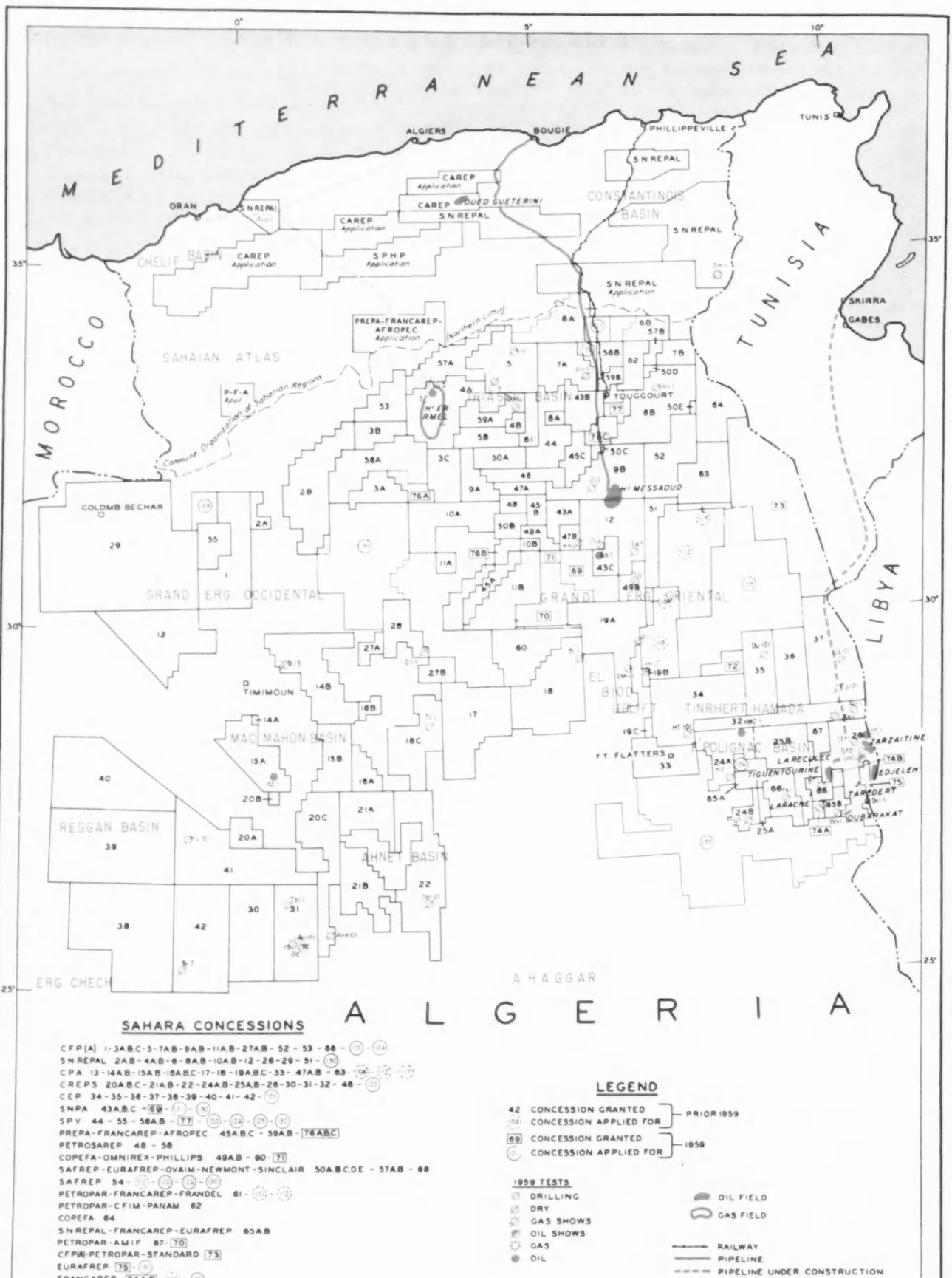
With the completion of the 24-inch crude oil pipe line from Edjele field to La Skirra due late this year, the Tunisian government made an agreement in mid-1960 with Ente Nazionale Idrocarburi (ENI) for construction of a Skirra refinery. The plant would process 20,000 bpd, fulfilling Tunisia's products needs and providing a surplus for export.

Algeria . . . new pipe lines allow production spurt

ALGERIA WAS on the threshold of becoming a major oil and gas producing area as of mid-1960. The 24-inch pipe line to move Hassi-Messaoud crude to the Mediterranean coast was completed late in 1959, and facilities were being completed in mid-1960 in the field to permit maximum production of about 120,000 bpd. Another 24-inch pipe line to provide an outlet for Edjele, Tiguentourine, Zarzaitine, and other extreme eastern Algerian oil fields is scheduled for completion late this year. A gas pipe line was also under way to provide an outlet for vast reserves at Hassi R'Mel and other gas fields in the Sahara. Facilities to liquefy methane for export from Mediterranean ports in Algeria were planned; and surveys to determine the feasibility of submarine natural gas pipe lines to link Sahara gas fields with western European markets were also under way in mid-1960.

Strong exploratory and development drilling activity intended to prove large enough reserves to justify the huge required pipe line projects, and to provide large enough productive capacity to utilize new pipe line capacity reached a climax in 1959. There were 149 completions and more than a million feet of hole recorded last year.

Crude oil production jumped abruptly last year upon the completion of the 410-mile, 22/24-inch pipe line from Hassi-Messaoud field to the Mediterranean port of Bougie (PIPE LINE INDUSTRY, April 1960, pp. 36-39). The line was completed in November, and delivered about 90,000 barrels of Hassi-Messaoud crude daily from SN REPAL's and CFP (A)'s wells during the last two months of



SAHARA CONCESSIONS

CFP(A) 1-3A.B.C-5-7A.B-9A.B-11A.B-27A.B-52-53-66-(72)-(74)
SNREPAL 2A.B-4A.B-6-8A.B-10A.B-12-26-29-51-(76)
CPA 13-14A.B-15A.B-16A.B.C-17-18-19A.B.C-33-47A.B-63-(104)-(112)-(113)
CREPS 20A.B.C-21A.B-22-24A.B-25A.B-28-30-31-32-46-(115)
CEP 34-35-36-37-38-39-40-41-42-(71)
SNPA 43A.B.C-69-(71)-(76)
SPV 44-55-56A.B-77-(110)-(124)-(129)-(130)
PREPA-FRANCAREP-AFROPEC 45A.B.C-59A.B-76A.B.C
PETROSAREP 48-58
COPEFA-OMNIREX-PHILLIPS 49A.B-60-71
SAFREP-EURAFREP-OVAIM-NEWMONT-SINCLAIR 50A.B.C.D.E-57A.B-68
SAFREP 54-(102)-(122)-(124)-(130)
PETROPAR-FRANCAREP-FRANDEL 61-(110)-(112)
PETROPAR-CFIM-PANAM 62
COPEFA 64
SNREPAL-FRANCAREP-EURAFREP 65A.B
PETROPAR-AMIF 67-70
CFP(A)-PETROPAR-STANDARD 73
EURAFREP 75-(5)
FRANCAREP 74A.B-(110)-(76)
COPAREX 72-(110)
CFIM-FIP (7)-(127)-(128)
TOPCO-CALASIATIC (28)
RAP (18)
COPEFA-PHILLIPS (16)
PREPA (30)

LEGEND

42 CONCESSION GRANTED — PRIOR 1959
(104) CONCESSION APPLIED FOR — PRIOR 1959
69 CONCESSION GRANTED — 1959
(7) CONCESSION APPLIED FOR — 1959

1959 TESTS
- DRILLING
- DRY
- GAS SHOWS
- OIL SHOWS
- GAS
- OIL

- OIL FIELD
- GAS FIELD
- RAILWAY
- PIPELINE
- PIPELINE UNDER CONSTRUCTION
- PROPOSED PIPELINE

0 100 200 MI.

Source: American Association Of Petroleum Geologists Bulletin

ALGERIA

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At the end of 1950, Hassi-Messaoud field had been proven about 28 miles long along its axis and about 24 miles wide in the middle. In the eastern area, Edjele field had been proven productive along a narrow 17-mile north-south structure. The northern portion is largely drilled up; the southern part was outlined by a few wells. At Zarzaitine, the oil field had been proven to be about 10 miles long and about 4 miles wide. Eight oil wells had been completed at Tiguentourine by the end of 1959, 3 at El-Adeb-Larache, 2 at La Reculee, and 2 at Ouan-Taredjele, north of Zarzaitine.

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Exploration highlights in 1959 and 1960 are summarized as follows:

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- Mobil International Oil Co. struck high API gravity oil in 1960 at Ohanet 1, located about 60 miles north of Zarzaitine field and just west of the new pipe line to Skirra. The well tested 1,900 bpd thru 1-inch choke from 7,740 feet.
- Farther north in the Triassic basin areas, SNPA found light oil at Hassi-El-Gassi 1, located about 50 miles south of Hassi-Messaoud. The discovery well was was drilled to 12,014 feet, with oil being found in Cambrian sandstones. However, the second test was a dry hole.
- In Northern Algeria, REPAL evidently found a new oil field in the Senonian limestones at Djebel Onk (DK 1), a rank wildcat in the Constantinois Basin, located 250 miles northeast of Hassi-Messaoud field near the Tunisian border.

Morocco

THE MOROCCAN oil outlook in mid-1960 was brighter than it had seemed in many years. Crude oil production in 1959 increased by 27.2 percent over the 1958 figure to 1,952 barrels daily (see table), due to extension of Haricha field in the Rharb Basin. An aerial magnetic survey of a 14,000-square-mile permit in southwestern Morocco had been completed, and Societa Marocchino-Italiana dei Petroli (SOMIP) was drilling a wildcat in mid-1960 near the Spanish Sahara border.

All current production is operated by Societe Cherifienne des Petroles (SCP), holder of four permits aggregating 7,600 square miles in Zone 1 (northern Morocco) south of Tangier. Development drilling at Haricha field last year raised capacity there to 1,500 barrels daily. Production is from the Dogger sandstones (Jurassic). All other reservoirs in Morocco, including Upper Bled Khatara, Upper and Lower Bled Eddoum, Upper and Lower Sidi-Fili, Lower Zrar, Lower Bled-Eddoum, etc. showed depleted crude oil yields last year compared to 1958, according to AAPG *Bulletin*

Crude Oil Production and Drilling in Algeria in 1959, by Companies[1]

Company[2]	Crude Oil Production In 1959		Wells Completed In 1959					Wells Drilling, End of 1959
			Wells					
	Total Barrels	Bbls. Daily	Oil	Gas	Dry	Total	Total Footage	
CFP (A)	4,205,865[3]	11,522[3]	17	..	3	20	233,928	8
SN Repal	4,956,526[3]	13,580[3]	17	..	4	21	248,717	9
CAREP	28,323[4]	78[4]	..	..	..	..	..	..
CREPS	.....	.....	78	7	9	94	383,939	4
CPA[5]	.....	.....	1	2	3	6	60,406	2
Others	.....	.....	2	..	6	8	101,041	7
Total	9,190,714	25,180	115	9	25	149	1,028,031	30

[1] Adapted from **Petrole Informations.** [2] Abbreviations identify operating companies as follows: CFP (A)—Compagnie Francaise des Petroles (Algerie); S N REPAL—Societe Nationale de Recherche et d'Exploitation des Petroles en Algerie; CAREP—Compagnie Algerienne de Recherche et d'Exploitation Petroliere; CREPS—Compagnie de Recherches et d'Exploitation de Petrole au Sahara; CPA—Compagnie des Petroles d'Algerie. [3] From Hassi-Messaoud field. [4] From Oued Gueterini field.

Crude Oil Production and Drilling in Morocco in 1959*

(Development by Societe Cherifienne des Petroles)

Crude oil production, barrels, in 1959	712,324
Barrels daily in 1959	1,952
Barrels daily in 1958	1,534
(Percent change in 1959)	+27.2
Wells completed in 1959, total	22
Oil	8
Gas	1
Dry	13
Footage drilled in 1959	73,545
Footage drilled in 1958	66,344
Wells drilling at end of 1959	1

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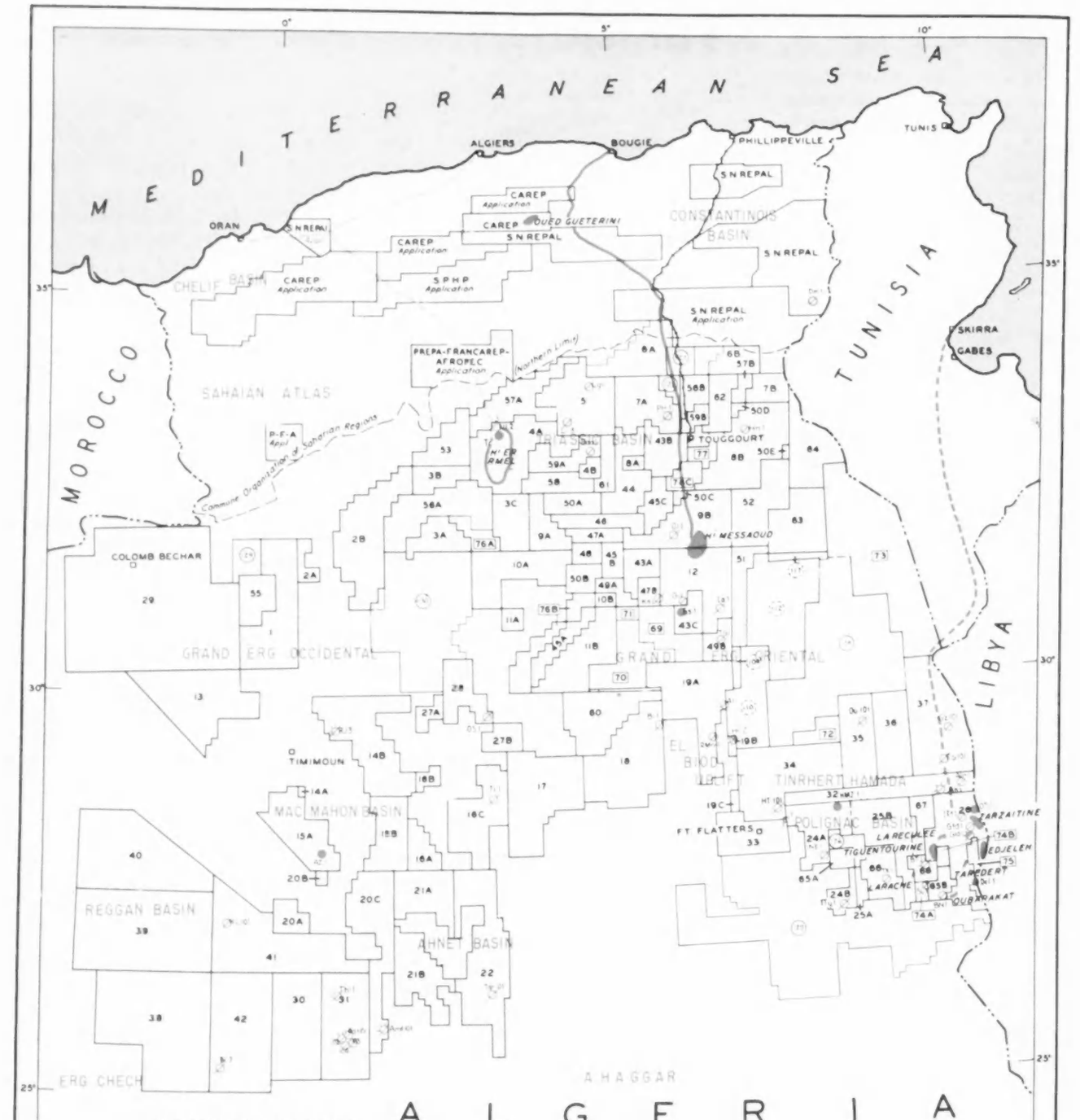

SAHARA CONCESSIONS

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SPV 44-55-56AB-(77)-(22)-(24)-(29)-(15)
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COPEFA-OMNIREX-PHILLIPS 49AB-60-(71)
SAFREP-EURAFREP-OVAIM-NEWMONT-SINCLAIR 50ABCDE-57AB-68
SAFREP 54-(10)-(12)-(24)-(30)
PETROPAR-FRANCAREP-FRANDEL 61-(10)-(12)
PETROPAR-CFIM-PANAM 62
COPEFA 64
S.N.REPAL-FRANCAREP-EURAFREP 65AB
PETROPAR-AMIF 67-(70)
CFP(A)-PETROPAR-STANDARD (73)
EURAFREP (75)-(76)
FRANCAREP (74AB)-(10)-(30)
COPAREX (72)-(10)
CFIM-FIP (11)-(27)-(28)
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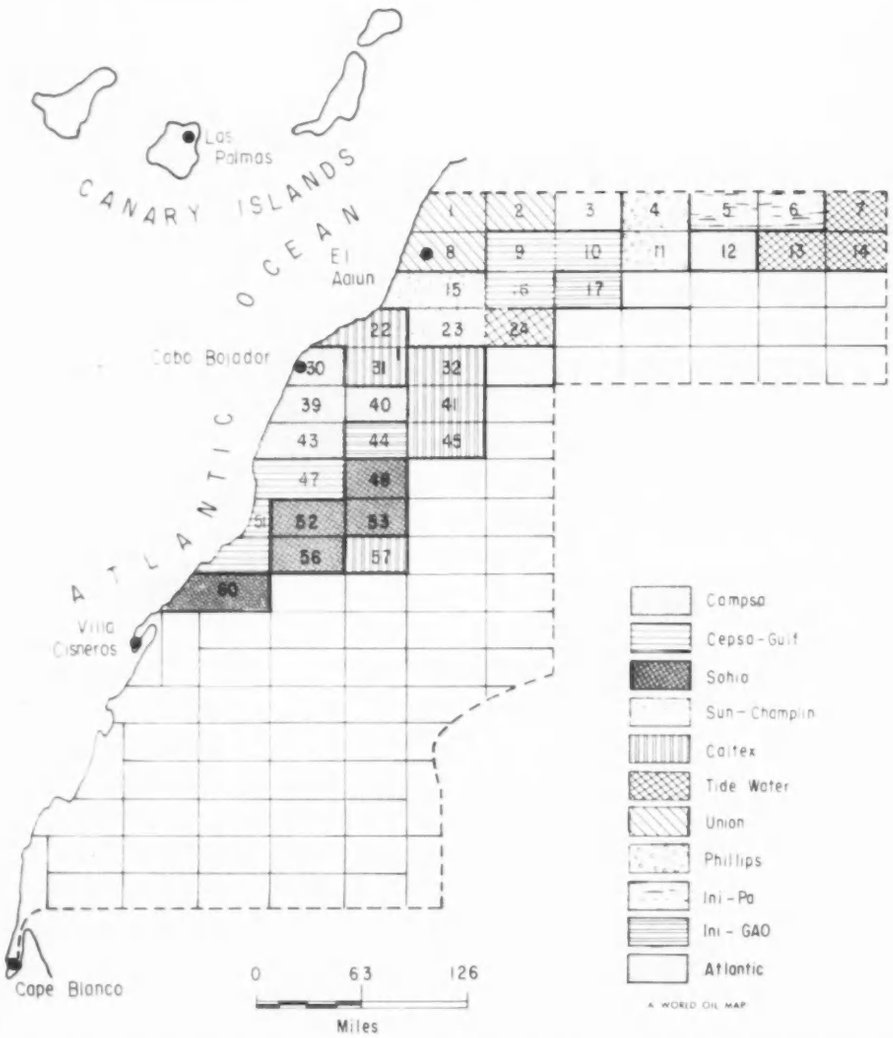
44, No. 7 (1960). Development in 1960 was to be concentrated at Haricha.

SOMIP is a joint-interest enterprise owned by AGIP Mineraria and the Moroccan government. It holds 14,000 square miles in Tarfaya province and the continental shelf. ENI has also set up a joint Italian-Moroccan government firm to build and operate a 25,000 bpd refinery at Mohammedia, 20 miles from Casablanca. The new plant is to go on stream in 1962.



Spanish Sahara activity is getting under way rapidly, with eleven separate groups holding acreage blocks as of mid-1960. Aerial photographic and magnetic coverage has been provided. Gulf had shipped a stratigraphic rig to drill in blocks 47 and 51 at mid-year. Tenerife refinery in Canary Islands would provide a convenient outlet in case crude oil is found in the Spanish Sahara.

Spanish Sahara . . . evaluation studies proceeding rapidly; drilling expected to commence

THE SPANISH GOVERNMENT granted exploration permits in zone 3 (Spanish Sahara) under the new petroleum law early in 1960, paving the way for vigorous efforts by several companies and groups to evaluate their holdings.

The Spanish Sahara covers about 100,000 square miles. Spanish West Africa originally included in addition about 12,700 square miles which was transferred to Morocco in 1956 and now forms the Moroccan province of Tarfaya.

The average size of permits granted so far is about 600,000 acres. As shown on the map the Caltex group received six blocks; Standard Oil Company (Ohio) CEPSA-Gulf (Compañía Española de Petróleos and Spanish Gulf Oil Company), five each; CAMPSA-Richfield-Cities Service and Tidewater Oil Company, four each; Union Oil Company of California, three Hispanic Sun-Champlin, INI-Valdebro, INI-Pan American, and Phillips Petroleum Company, two each; and Atlantic Refining Co., one block.

By mid-1960, two groups already had prepared to commence drilling. Falcon Seaboard Drilling Co. shipped a rig from Houston in June to commence an 18-month contract with Gulf in blocks 47 and 51. Gulf expected to drill a series of 1,500-foot stratigraphic tests in these coastal blocks.

Union Oil Company of California planned to drill its first deep test to 13,500 feet, commencing in October. Union and its partner, Compañía Iberica de Petróleos began seismic and surface geologic work early in 1960 in its three tracts covering 1,750,000 acres. Tidewater became the operator for eight licenses awarded to it and to Sohio.

Although the geology of Spanish Sahara was little known two years ago, the area is being evaluated very rapidly. Aero Service Corp and Huntings Ltd. flew a 70,000-square-mile airborne magnetometer survey in 1959, covering the entire sedimentary portion. Some flight lines were extended to help determine the magnetic nature of the basement, a crucial factor in exploration for Sahara oil.

Recent surface geological work has established the presence of a small pre-Cambrian inlier located west of the limit of crystalline outcrops which occur south of the areas now subject to permits. A newly-found belt of Cambro-Ordovician apparently runs approximately south-north along meridian 12° west (i.e., between blocks 9 and 10), and probably ties in with a similar belt in the Anti-Atlas Mountains in Morocco. It is likely that some pre-Cambrian lies *west* of this belt. This inlier of ancient sediments, in effect, may cut the presumed northern Spanish Sahara sedimentary basin in half and may isolate the western part from highly prospective marine Paleozoic beds, particularly Devonian, in the Tindouf Basin. The SOMIP Dum Doul 1 wildcat being drilled early in 1960 in Tarfaya just north of Pan American's block 6 in Spanish Sahara may be a very important test in this regard.

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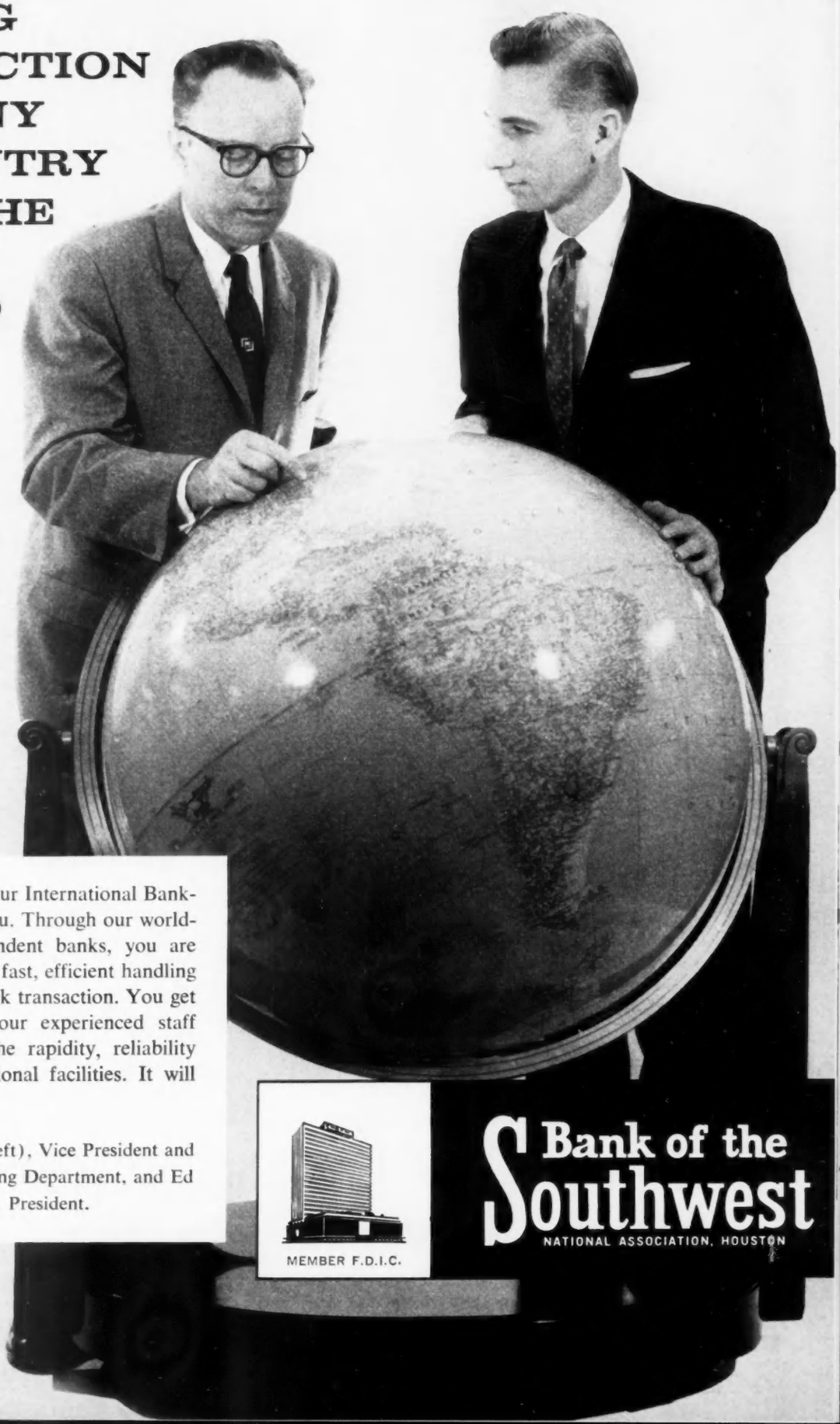

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Photo: Merle R. Crockard (left), Vice President and Manager, International Banking Department, and Ed Chapline, Jr., Assistant Vice President.

MEMBER F.D.I.C.

Bank of the Southwest
NATIONAL ASSOCIATION, HOUSTON

Western Africa . . . production estimates in Nigeria are 100,000 bpd by 1966

NIGERIA is becoming an important oil-producing country. Estimates of future production were running as high as 100,000 barrels daily by 1966.

Oil exploration was being pushed in a number of newly independent members of the French community; notably the Mali Federation (Senegal and the French Sudan), Ivory Coast, Cameroon, and Mauritania. One oil well was completed in each of two of these countries, Senegal and Cameroon, in 1959, and tests were awaited to determine if the finds were commercial. Exploration also continued in Portuguese Guinea, where wildcatting is to commence later this year.

Mauritania

MAURITANIA has become an independent republic. The coastal strip was under concession all the way from Spanish Sahara on the north to Senegal on the south. Societe de Participations Petrolieres (Petropar) applied for the 14,848 square-mile Port Etienne permit, including about 5,350 square miles offshore, on Jan. 19, 1959. Late last year a joint venture agreement covering the 12,847 square-mile Nouakchott permit was concluded between Societe Africaine des Petroles (SAP), designated as operator, Societe de Recherches et d'Exploitation du Petrole (EURAFREP), Senegal Cities Service Petroleum Corp., and Continental Oil Co. of Senegal. Eurafrep and Cities Service each have 25 percent interest; SAP has 26 percent and Continental, 24 percent. Some seismic work was being done at the end of 1959.

Mali Federation

THE MALI FEDERATION, composed of two former French territories of Sudan and Senegal, adopted Ordinance Law No. 4 establishing legal and tax provisions governing exploration, exploitation, and transportation of hydrocarbons on December 22, 1959. The Mali Federal Assembly, central legislative body of these two West African member states of the French community passed the new law based on French legislation applying to the Sahara.

Basic royalty rates of 12.5 percent on oil and 5 percent on natural gas can be lowered by mutual agreement between the government and the operator when annual oil production is less than a million metric tons or gas production is less than 300 million cubic meters. The combination of royalties and taxes will average 50 percent of net profits. There is a 27.5 percent depletion provision.

Senegal. Exploration continued in Senegal in 1959 and 1960. A test drilled by SAP 30 miles east of Dakar flowed 50 barrels of 39° API gravity oil in four hours from about 3,300 feet in January 1960. The same test flowed about 2 million cubic feet of gas from about 2,600 feet. Final results on this test were being awaited.

SAP drilled 47,201 feet of hole on its 4,150 square mile Dakar permit in 1959. Seven wells were completed, varying in depth from 4,639 to 11,483 feet. Of six dry holes, four had noncommercial gas shows in Cretaceous beds. The seventh well was testing oil in January.

Societe des Petroles du Senegal (SPS) continued active exploration on its permits east of Dakar and south of British Gambia. SPS drilled 37,749 feet of hole and completed five dry holes varying from 2,411 to 13,461 feet. Three deep tests reached basement. N'Dofane 1, located about 120 miles southeast of Dakar, was being drilled at 11,013 feet at the end of 1959.

Sudan (French). Field geology in the southern border of the Paleozoic Taoudeni Basin was done by SAP and SPS last year, according to AAPG *Bulletin* 44, No. 7 (1960).

Portuguese Guinea

ESSO EXPLORATION GUINE, INC. conducted active exploration in 1959 on its five-year, 11-million-acre concession granted in February 1958. Surface geology and gravity and seismic work were done. A drilling contract was concluded in 1960, and the first wildcat was expected to be spudded early this fall.

Liberia

SOME RECONNAISSANCE geological work was reported in 1959 on a 1.5 million acre concession granted in 1958 to a U.S. group headed by Richard H. Robinson of Oklahoma City. The concession was reported cancelled in 1960.

Ivory Coast

SAP CONTINUED EXPLORATION on its Ivory Coast permit in 1959 and 1960. The deep first test, Port Bouet 1, located on a seismograph prospect, was reported drilling at 7,070 in lower Cretaceous at the start of 1959. This well bottomed at 12,917 feet in September, still in lower Cretaceous (Aptian or Albian) according to AAPG *Bulletin* 44, No. 7 (1960). Another deep test, Berou 1 was spudded at a location farther east toward the Ghana border and was drilling at 8,484 feet at the end of December. A deep, narrow coastal basin has been established along the Ivory Coast. Tar sands and heavy oil seepages occur in the eastern part of the basin in both Ivory Coast and Ghana.

In mid-1960 the U.S. interests formerly involved in the Ivory Coast venture, Plymouth Oil Co., Benedum-Trees Oil Co. and the estate of Michael L. Benedum withdrew from the operation.

Nigeria

NIGERIA is well on its way to becoming an important oil-producing area, and is scheduled to become an independent nation later this year. A favorable environment for private capital has been created, and several new companies are known to be interested in acquiring exploration licenses. Tennessee Nigeria Inc., a subsidiary of Tennessee Gas Transmission Company has been organized to operate a 1.2 million acre license located on the coast east of Lagos. Pan American International Oil Co. and Standard Oil Co. (New Jersey) were also reported interested in acquiring Nigerian exploration licenses. Early in 1960 the Nigerian government adopted procedures for granting such licenses, and on March 1 stated

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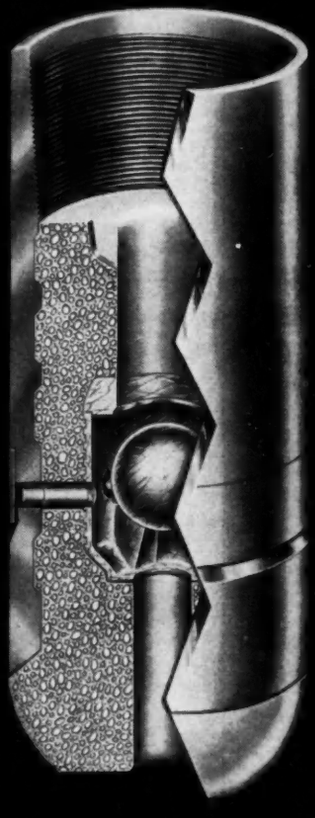

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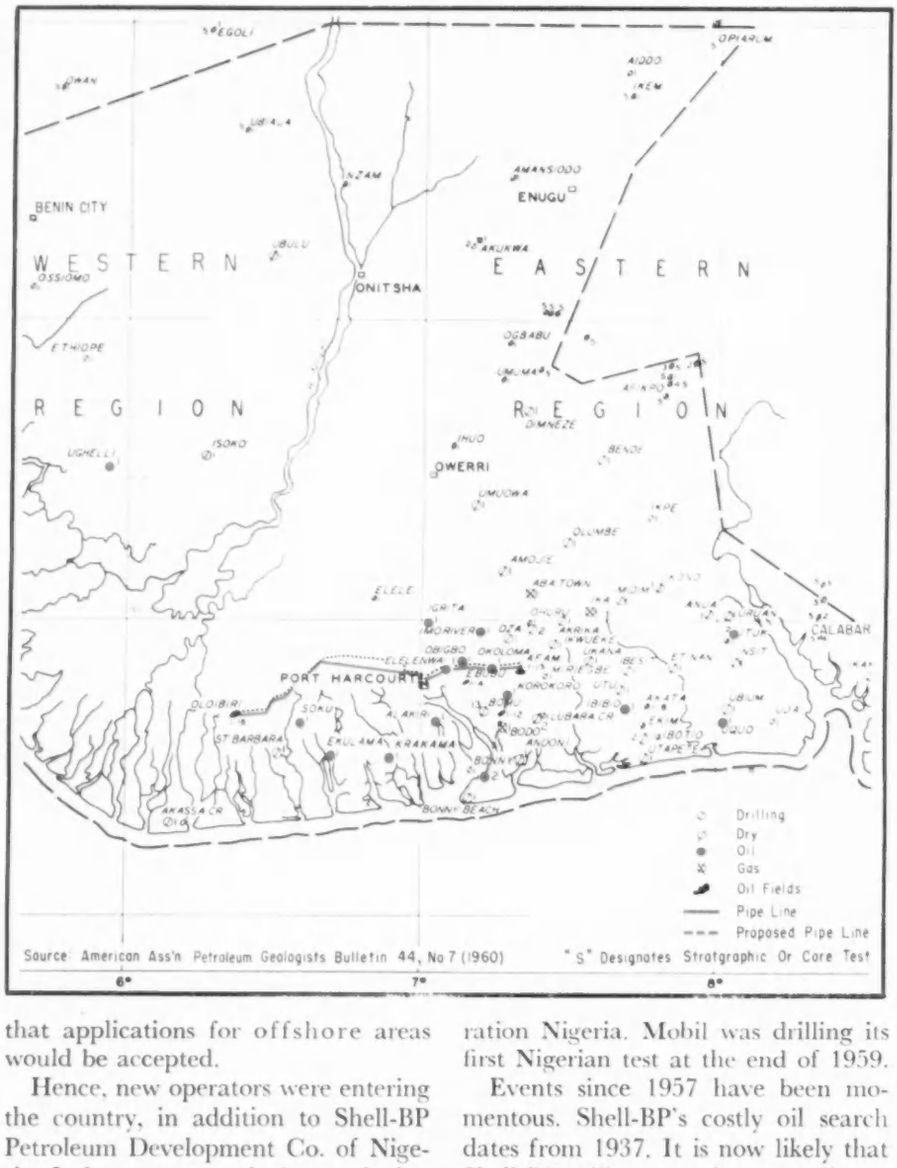
OIL FIELD AND PIPE LINES IN NIGERIA



that applications for offshore areas would be accepted.

Hence, new operators were entering the country, in addition to Shell-BP Petroleum Development Co. of Nigeria Ltd., operator of six producing oil fields in 1959, and Mobil Exploration Nigeria. Mobil was drilling its first Nigerian test at the end of 1959.

Events since 1957 have been momentous. Shell-BP's costly oil search dates from 1937. It is now likely that Shell-BP will recoup its expenditures by 1965 or before. Substantial crude oil reserves have been developed. Crude oil production in 1959 averaged 15,782 bpd (Table 1), more than three times the 5,017 bpd figure of 1958. Crude oil output in December 1959 averaged 22,387 bpd. Shell-BP's production is expected to reach 90,000 barrels daily in Nigeria by 1965. Construction of a refinery was being considered.

Drilling. Shell-BP completed 16 development wells (Table 1, less the discovery wells of Ebubu and Okoloma fields) and 37 wildcats last year. Seven additional Shell-BP wildcats were underway at the end of December. Total footage drilled in Nigeria last year was 537,387 feet, according to A A P G *Bulletin* 44, No. 7 (1960).

Of the wildcats, completed last year the following nine tested oil: Imo River 1, Korokoro 1, Bonny 2, Okoloma 1, Ughelli 1, Elelenwa 1, Igrita 1, Alakiri 1, and Ibibio 1; and the following three tested gas; Bodo 1, Ika 1, and Aba Town 1. The Ughelli oil discovery was particularly significant in that it is 65 miles north-northwest of Oloibiri. Oloibiri is the westernmost of a string of oil fields located in the coastal strip east of the Niger River.

In other exploration, Shell-BP added an eighth seismic party at the start of 1960; six had worked during 1959. The newest crew started work in the western region of Shell-BP's permit near the Ramos River, 30 miles southwest of Warri.

TABLE 1—Crude Oil Production, Producing Wells, and Development Drilling in Nigeria in 1959, by Fields

Name of Field (or Area)	Ebubu	Oloibiri	Afam	Okoloma	Bomu	Elenwa	Total[4]
Year of discovery	1958	1956	1957	1959	1958	1959	
Footage drilled in 1959	27,408		19,050	10,040	84,680	11,000	152,178
Total wells completed in 1959	3		2	1	11	1	18
(a) Oil wells	3		2	1	11	1	18
(b) Gas wells							
(c) Dry holes							
Wells drilling at end of 1959							
Suspended wells at end of 1959		1		1[1]		1[2]	3
Flowing wells at end of 1959	4	10	6		6		26
Pumping wells at end of 1959							
Wells drilled to end of 1959	4	16	13	1	12	1	47
Producing depths, feet	8,200-8,500	8,000-9,800	9,000-9,400	8,800-9,100	7,100-7,500	10,300-10,380	
Crude production in 1959, bbls.	756,308	1,725,583	1,094,229	25,827	359,878	23,026	3,984,851
Crude production in Dec. 1959, bpd	4,605	5,599	2,748	530	8,307	598	22,387
Cumulative crude production to end of 1959, bbls.	756,308	2,708,296	1,736,800	25,827	510,220	23,026	5,760,477
Base of crude	Paraffin	Paraffin	Paraffin	Paraffin	Paraffin	Paraffin	
A.P.I. gravity of crude	26°-30° (27.5°)[3]	20°-29° (22°)[3]	36°-55° (43°)[3]	50°	32°-38°	38°	
Age of producing formation	Miocene	Miocene	Miocene	Miocene	Miocene	Miocene	

SOURCE: Royal Dutch Shell semi-annual oil field statistical data.
[1] Produced 10 days during December. [2] Produced 11.5 days during December. [3] Figures in parentheses are average field API gravities. [4] Akata and Soku fields, included in 1958 statistics, were not produced or drilled in 1959.

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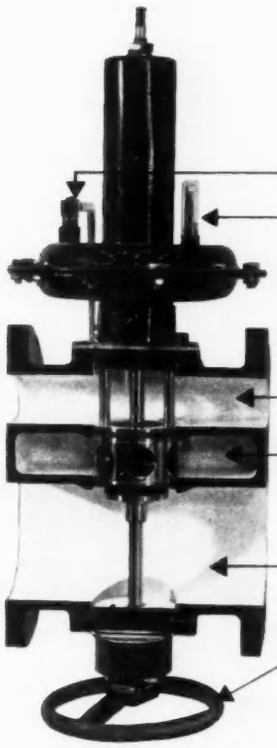
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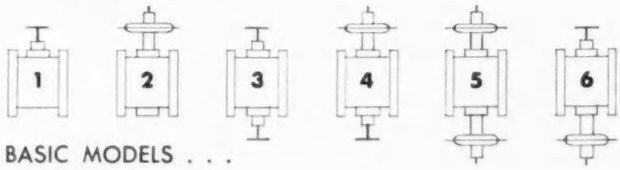

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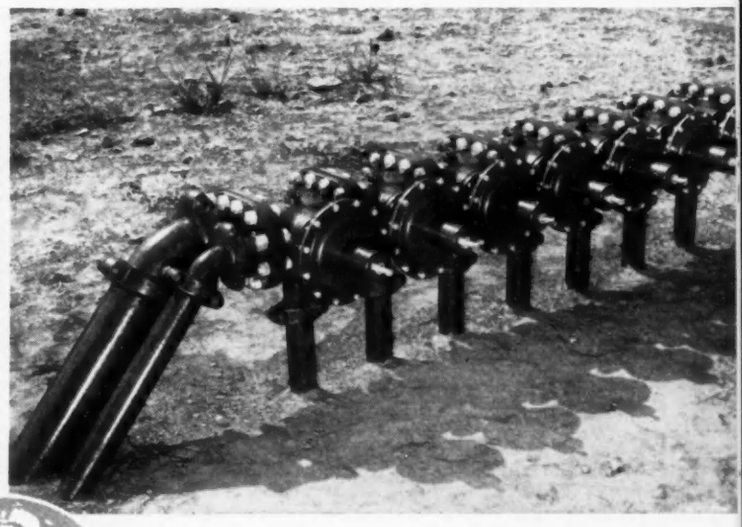

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Southern Africa . . . crude oil production, drilling, and exploration proceed steadily

PETROLEUM DEVELOPMENT in Southern Africa is continuing steadily. A new oil field was found in Gabon, and crude output rose. Oil production has started at Pointe Indienne, Congo Republic. Angola is gaining new fields. Exploration is under way in Spanish Guinea, Cabinda, the Belgian Congo, and South West Africa. Many areas were being re-evaluated.

Ghana

ALTHOUGH NO ACTIVITY was reported by Gulf Oil Co. of Ghana in 1959, an aerial survey was reported in 1960 pursuant to a contract between the government and Hunting Surveys Ltd. Two areas aggregating about 6,500 square miles were to be covered by aerial photography and later by aerial magnetometer and scintilometer.

The Italian oil agency ENI was reported negotiating with the Ghana government late in 1959 concerning possible exploration permits, but nothing further was reported by mid-1960 as to the outcome.

Dahomey

SOCIETE DES PETROLES DU DAHOMEY (SOPEDA) was formed in October 1959 to search for oil in Dahomey. Three permits in the southern, sedimentary part of Dahomey along the Nigerian frontier, including one offshore permit, were granted by the government on November 12, 1959, according to *Petrole Informations*.

Niger Republic

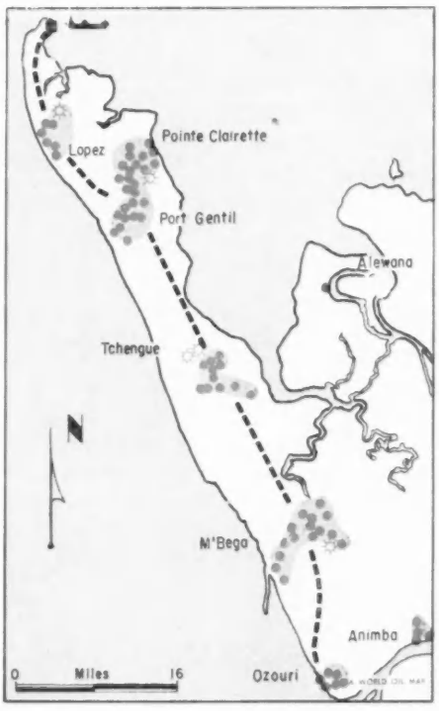
STANDARD OIL COMPANY (New Jersey) received a six-month prospecting license covering 90,000 square miles in November 1959. This license covers virtually the entire sedimentary area of Niger, and a field geological crew started work at the end of 1959, according to AAPG *Bulletin* 44, No. 7 (1960). Mobil Exploration West Africa Inc. completed field geology and refraction seismic work in 1959 in the Cretaceous-Paleozoic basin between the Ahaggar to the north and Nigeria to the south.

Cameroons

SOCIETE DE RECHERCHES ET D'EXPLOITATION DES PETROLES DU CAMEROUN (SEREPCA) continued operations in 1959 and 1960. Some gas and condensate has been found in the French Cameroons in previous years. Kwa-Kwa 1, located about 24 miles south of Douala was reported drilling below 3,600 feet at the start of 1959. This well bottomed at 5,766 feet in Maestrichtian on April 12, 1959. About 25 feet of porous Eocene oil sand was found at 3,830 feet. The well was testing 100 bpd of 31° API gravity crude in mid-1959.

Gabon . . . crude oil yield exceeds 15,000 bpd

CRUDE OIL YIELD increased last year as anticipated in the Gabon Republic, while drilling rates slacked off to a more normal pace. Crude oil output amounted to 5,529,203 barrels (see Table) from seven fields, averaging 15,148 bpd in 1959, representing an abrupt 54.3 percent increase from the 9,817 bpd rate of 1958. Drilling decreased by about half in 1959, when 42 completions and 192,981 feet of hole were recorded, compared with 96 completions and 445,483 feet during the peak year of 1958.



Crude yield from Gabon this year was expected to be 800,000 tons, or an average of 16,000 bpd. Production during the first six month of 1960 averaged 16,320 barrels daily, and June production was 15,880 bpd. Five rigs were operating in Gabon at midyear. Hence, it appeared that producing, drilling, and exploration activities had reached a more routine stage.

Production. Operations are conducted by Societe des Petroles d'Afrique Equatoriale (SPAFE). Crude is moved by pipe line from Cap Lopez, Pointe Clairette, M'Bega, Techengue, and Ozouri fields to a marine terminal at Cap Lopez; and is barged from two smaller fields, Animba and Alewana to the Cap Lopez terminal. Producing fields are listed in decreasing order of 1959 output in the accompanying Table.

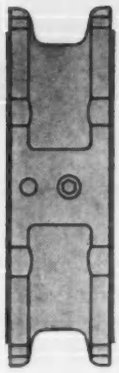
It is noteworthy that M'Bega surpassed Pointe Clairette last year to be-

Crude Oil Production and Drilling in Gabon in 1959[1]

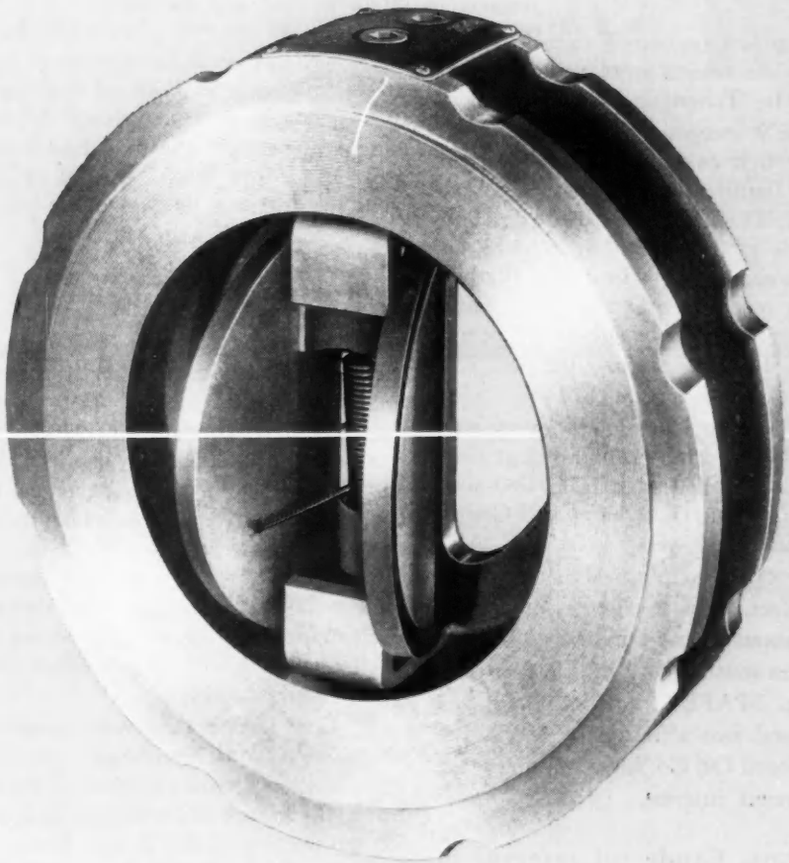
FIELD	Production 1959 Total Bbls.	Production 1959 Bbls. Daily	Production 1958 bpd	Oil Gravity Deg. API	Age of Producing Formation	Producing Depths (feet)	Wells Completed in 1959 Oil	Gas	Dry	Total	Footage Drilled in 1959 (feet)	Wells Drilling at Yr. End
M'Bega	1,768,811	4,846	3,248	27	L. E.[2]	3,350	..	..	..	..	.....	..
Point Clairette	1,635,980	4,482	3,789	32.1	U. S.[3]	2,600–5,000	..	..	..	..	.....	..
Cap Lopez	703,502	1,927	190	31.6	U. S.[3]	5,700	7	..	3	10	60,698	1
Ozouri	697,074	1,910	2,482	20.6	L. E.[2]	2,000–2,300	..	..	..	..	.....	..
Tchengue	494,240	1,354	.....	31.25	M.[4]	3,800[7]	11	..	2	13	49,253	2
Animba	136,542	374	.....	13	L. E.[2]	1,700–1,800	..	..	..	..	.....	..
Alewana	93,054	255	108	33	C. R.[5]	2,900	..	..	..	..	.....	..
Sub-Total[6]	5,529,203	15,148	9,817	.....	.....	.....	18	..	5	23	109,951	3
Wildcats	.....	.....	.....	.....	.....	.....	1	1	17	19	83,030	1
Total	5,529,203	15,148	9,817	.....	.....	.....	19	1	22	42	192,981	4

[1] Adapted from **Petrole Informations** and The American Association of Petroleum Geologists **Bulletin** 44, No. 7 (1960) [2] Lower Eocene. [3] Upper Senonian. [4] Miocene. [5] Cap rock. [6] Production, and development drilling. [7] or deeper.

fits between the flanges



less space—weighs only 10% as much



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69—100

GABON

come Gabon's leading oil field. On the other hand, Ozouri field declined from 2,482 bpd in 1958 to 1,910 barrels daily in 1959. Attempts to waterflood Ozouri did not meet with success in 1959, and the wells were not flowing.

Drilling was most active in Tchengue field, which has recently become an important source of oil after being brought in originally as a gas field. Thirteen wells, including 11 oil wells were completed at Tchengue last year, and almost 50,000 feet of hole was drilled there. Drilling was also very active in the new Cap Lopez field. Nineteen wildcats were also drilled.

Exploration remained vigorous, and some good results were reported last year. The Tchengue field was found to have a steep-sided east-west Miocene trough overlying the salt dome. Salt is found at 5,000 feet. The first oil well, TC 5, was completed in 1959 in sands at 3,780 feet thought to be of Senonian age. However, further drilling revealed that the thick, lenticular sands in this trough are Miocene in age. The best well so far had 125 feet of oil sand.

The Rembo Kotto 1 discovery was the only important rank wildcat find last year. Drilled in a 6,175,000-acre area straddling the Gabon and Congo republics, this well tested 47° API gravity crude at about 340 bpd from 1,900 feet. The discovery well is located about 25 miles inland and about 50 miles southeast of the nearest production. SPAFE is the operator of this area, and two affiliates of Mobil International Oil Co. have an aggregate 50 percent interest.

Reserves. Crude oil reserves in Gabon at the end of 1959 were estimated at 63 million barrels.

Spanish Guinea

AN EXPLORATION permit was reported granted jointly to the Spanish firm Compañía Española de Petróleos, S. A. (CEPSA) and Spanish Gulf Oil Co., the only applicants as of the end of 1959. Spanish Guinea lies north of Gabon and is also known as Rio Muni.

In July 1960 Aero Service Corp. and Huntings Ltd. were to conduct aerial photographic and magnetic surveys covering 1,350 square miles.

Republic of Congo

CRUDE OIL production began in June 1960 in the Republic of the Congo's lone field, Pointe Indienne, operated by SPAFE. Output was 6,540 tons, or 48,945 barrels of 36.5° API gravity crude, an average of 1,632 barrels daily during the month. Planned output during 1960 from Pointe Indienne was 50,000 tons, or about 1,000 bpd for the year. Crude was to be pipelined to storage facilities at the mouth of the Rouge River between Pointe Indienne and Pointe Noire, and tankers were to be loaded offshore from this location.

Ten wells were finished at Pointe Indienne last year, completing the field's development. Four oil wells and three gas wells were completed. At the end of December, the field had 8 oil wells and 6 gas wells. A total of 12 wells were drilled in Congo last year, aggregating 63,454 feet of hole.

Belgian Congo

THE BELGIAN CONGO, which was the scene of so much civil disorder upon gaining its independence from Belgium at midyear 1960, was the scene of some oil activity also in 1959 and 1960. A new mining decree to regulate exploration and development of hydrocarbons was published in the Official Gazette of the Belgian Congo on April 15, 1959. The new decree embodies the 50-50 profit-sharing principle and sets forth procedures for petroleum concessions.

In June 1959 a pact was signed by Forminiere and Petrobelge granting these companies oil exploration rights on 1,700 square miles in the Belgian Congo portion of the Congo Basin. It includes the territorial waters of the Congo River on the south from Banana to the coast, thence northward to the Cabinda border and east to a north-south line running about 9.4 miles west of the Tshela-Boma road. An aeromagnetic survey was completed early in 1959 covering this acreage and Cabinda Gulf's also. Petrofina's Congo Basin acreage in Angola was also covered.

Petrobelge was to start exploration in July 1960 with a Petrofina seismic crew moved from Angola.

Cabinda

CABINDA GULF OIL CO. continued deep drilling during the first half of 1959. Bucomazi 1, located seven miles north of Cabinda town was abandoned at 9,435 feet in basement. Malembo 1, located on the coast about 10 miles still farther north was drilled to 8,482 feet in basement and was dry also. An extensive structure drilling program was begun in November upon arrival of a smaller, more portable rig, and more than 30,000 feet of structure hole was drilled by the end of the year, according to AAPG *Bulletin* 44, No. 7 (1960). This program was to be continued into 1960, together with gravity and seismic work and surface geology.

Angola

OIL EXPLORATION in Angola continues to meet with success. Petrofina, the Belgian firm, confirmed an important oil field at Galinda 2, located in the Cuanza Basin about 30 miles southeast of Benfica field. Galinda 2 was drilled to 7,280 feet. Initial production tests of the Aptian limestone yielded 315 barrels of oil daily on a 1/8-inch choke. The initial well, Galinda 1, had been drilled to 11,320 feet, and had tested 10 barrels of oil daily from the Aptian limestone of the Cretaceous.

Also in the Cuanza Basin, Petrofina completed Bom Jesus 1, located

Production and Drilling in Angola in 1959

Company and Field	Crude Oil Production in 1959		Oil Producing Wells at End of 1959			Wells Completed in 1959					Wells Drilling End 1959
	Total Barrels	Bbls. Daily	Flowing	Pumping	Total	Oil	Gas	Dry	Total	Footage	
Petrangol	292,243	801	10	1	11	3	...	..	3	18,500	..
Benfica	194,556	533	*	*	*	3	...	..	3	18,500	..
Luanda	97,687	268	*	*	*	..	...	..	..	.....	..
Petrofina	65,740	180	2	1	5[1]	5	...	8	13	114,000[2]	4
Cacuaco	63,044	173	*	..	2	2	...	4	6	*	1
Galinda	2,696	7	*	*	*	2	...	..	2	18,600	..
Bom Jesus	.....	...	..	..	..	1	...	1	2	19,630	..
Total	357,983	981	12	2	16[1]	8	...	8	16	132,500	4

Sources: Petrofina, and AAPG Bulletin 44, No. 7 (1960). * Breakdown not available. [1] Includes 2 oilwells shut in. [2] Includes drilling on 4 other wildcats.

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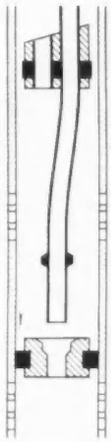

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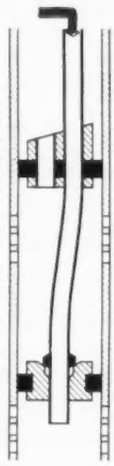
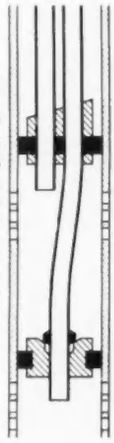
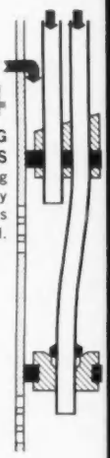
RUNNING IN
Made up on long string are Model J upper packer and lower-packer sealing accessories.



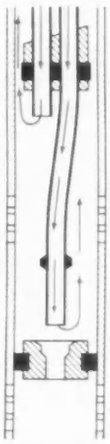
2
SETTING UPPER PACKER
When sealing accessories "locate" in lower packer, set-down weight on long string sets and packs off Model J Packer. Repeat setting simplifies spacing out. Now test lower packer if desired.



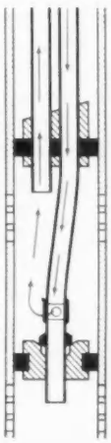
3
RUNNING AND INSTALLING SHORT STRING
Seal on short string "snap latches" into upper packer. Pull back to test for surface indication of seating.



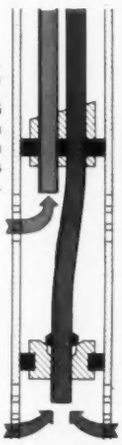
4
TESTING PACKERS
Pack-off tubing at surface; apply pressure as indicated.



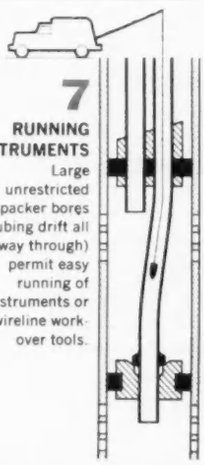
5 a
DISPLACING WITH TUBING PACKED OFF
Pick up and displace both strings. Set back down with set-down weight to pack-off packers and produce.



5 b
DISPLACING FLANGED-UP USING CIRCULATING OR COMPLETION VALVES
If displacing with head on, as in 5a, or flanged-up, as in 5b, isn't required, there are other options.



6
PRODUCING
Now you're on production through packers that really hold.



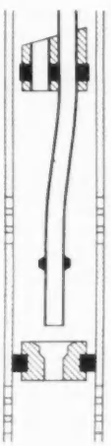
7
RUNNING INSTRUMENTS
Large unrestricted packer bores (tubing drift all the way through) permit easy running of instruments or wireline work-over tools.

Hold-downs on Double-Grip Versio

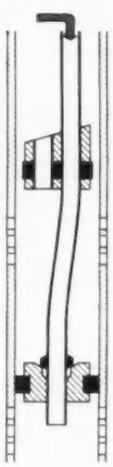
A reminder

Both Model J and Model K are available in single-grip or double-grip versions. Double-grip versions will permit pressuring operations later without having to pull packers.

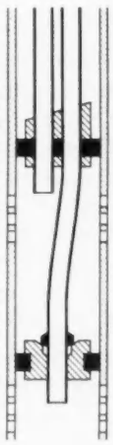
Most Model K hook-ups use the Baker Retainer Production Packer at the bottom, but Model K does permit you to run another retrievable packer at bottom if you want to. It also permits you to keep the long string in natural tension if desired. The pictures demonstrate the simplicity of a Model K dual completion.



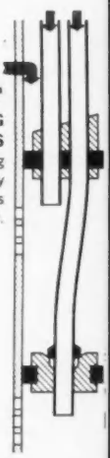
1
RUNNING IN
Made up on long string are lower-packer sealing accessories and Model K upper packer.



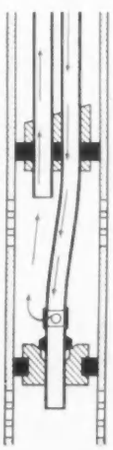
2
SEALING ACCESSORIES LOCATED IN LOWER PACKER
Now test lower packer if desired.



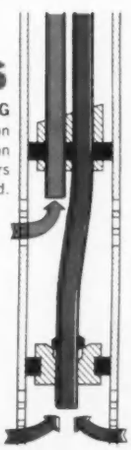
3
INSTALLING SHORT STRING AND SETTING PACKER
Seal on short string "snap-latches" into sealing bore. Weight set down on short string sets and packs off packer. Repeat setting simplifies spacing out.



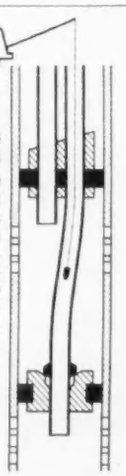
4
TESTING PACKERS
Pack-off tubing at surface; apply pressure as indicated.



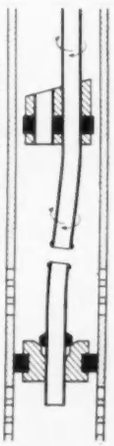
5
DISPLACING FLANGED-UP USING CIRCULATING OR COMPLETION VALVES
If displacing flanged-up isn't required, there are other options. Picking up and displacing both strings is a method for Model J only. (See 5a above.)



6
PRODUCING
Now you're on production through packers that really hold.

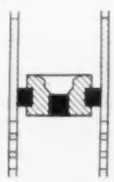


7
RUNNING INSTRUMENTS
Large unrestricted packer bores (tubing drift all the way through) permit easy running of instruments or wireline work-over tools.



USE OF OPTIONAL SAFETY JOINT
Because the long string can be rotated through Model K, a safety joint can be run if desired. (Cannot be done with Model J.)

OPTIONAL EXPENDABLE PLUG
Prior to running upper Model K packer, you can run a Baker Expendable Plug for upper zone work-over. Plug is knocked out when long string enters packer bore.



ANGOLA

about 10 miles east of Benfica field, for 80 barrels of oil daily from Aptian limestone. Total depth of the discovery well was 11,245 feet. Bom Jesus 2, drilled to 8,385 feet, was dry. Dry wildcats were also drilled at Muxima 1, Uacongo 2 and Cacoba 4.

Petrangol, the exploitation firm, completed 3 oil wells at Benfica field, and 2 oil wells and 4 dry holes at Cacuaco field. There were 16 completions in Angola last year, and 132,500 feet of hole was drilled.

Vigorous drilling activity continued in 1960. Twelve wells, including five core-drill tests, were completed during the first half of this year. Eleven more, including three core holes, were expected to be completed between July 1 and December 31.

Crude oil production was about the same last year as in 1958. Benfica, Luanda, Cacuaco, and Galinda fields were on production all or part of 1959, yielding a total of 357,983 barrels (981 bpd), a slight drop from the 987 bpd rate of 1958.

South West Africa

INTEREST CONTINUED in South West Africa's oil possibilities in 1959 and 1960. About 40 to 50 million acres were under lease this year.

In mid-1959, oil and gas rights in Diamond Area 2, a 7-million-square-mile area located along the coast south of Sandwich Bay and north of Luderitz were transferred to North American interests including Trans-American Mining Corp., Ltd., of Toronto, Can. Surface geology, magnetometer and other geophysical work were done. Drilling, to commence in 1960 or 1961, was being considered.

About half the area of two blocks totaling about 20,000 square miles, one on the coast between Sandwich Bay and Cape Cross, the other inland from Diamond Area 2, were assigned to Artnell Company of Chicago.

Conorada Petroleum Corporation has been doing surface geology in the southern part of the inland block. Artnell is expected to acquire the southern part of the inland block also if Conorada drops it.

Most active interest in South West Africa is centered near the southern tip of the Artnell coastal block (i.e., near Walvis and Sandwich bays).

Eastern Africa . . . progress in Egyptian region of UAR highlights 1959-1960 activity in area

PROGRESS was noted in the Egyptian region of the United Arab Republic (UAR) in 1959 and 1960. In the Suez Graben, the new Ras Bakr and Kreim oil fields were going on production in 1960 after successful development. An important discovery was made at Sidri, south of Abu Rudeis field. If the new well is, as it appeared, a long extension of Abu Rudeis, important new oil reserves were indicated.

The western desert area of Egypt was opened anew to bids from private interests. Geological exploration was also being conducted in adjoining areas in the Sudan, west of the Nile River.

Madagascar

SOCIETE DES PETROLES DE MADAGASCAR (SPM) continued its search for oil in 1959 and 1960. Activity continued early in 1960 with one heavy and one light rig in use. The firm holds a large permit in the southwestern part of the Island. The Morondava Basin was being explored.

SPM completed Belinda 1 at 8,297 feet and West Bemolanga 1 at 4,924 feet, both in basement, in the northwest part of the permit last year. The latter had bituminous shows. Belinda 2, east of 1, was drilling at 7,054 feet at the end of December. In the southwest part of the permit, Vohidolo 2 was abandoned at 11,365 feet in July 1959 after a fishing job. Well 2b, west of 2 was being drilled below 8,850 feet at the end of December, according to *Petrole Informations*. About 40,000 feet of full hole was drilled on Madagascar last year. In addition, there were 9 stratigraphic holes to depths varying from 221 to 1,478 feet, aggregating about 9,000 feet of hole, drilled last year.

Mozambique

MOZAMBIQUE GULF OIL CO. (Mozgoc) conducted geological and geophysical work in its 45,860 square-mile concession along the southeast coast in 1959, on behalf of itself and its partner, Mozambique Pan American Oil Co.

Construction of Mozambique's first refinery at Lourenco Marques by Sociedad Nacional de Refinacao de Petroles (SONAREP) began late in 1959. The plant will initially process 17,500 barrels of imported crude when completed early in 1961.

Zanzibar Protectorate

BP-SHELL DEVELOPMENT CO. LTD. completed four shallow tests on Pemba Island, part of the Zanzibar Protectorate, last year. Pemba 1 and 2 were both drilled to a depth of 2,500 feet. Pemba 3 bottomed at 518, and 4 at 2,912 feet. These tests were drilled on a gravity high to check Tertiary markers indicative of possible structure at greater depth.

Tanganyika

THE MANDAWA 7 deep test, being drilled at the start of 1959 by BP-Shell Petroleum Development Co. Ltd. about 20 miles inland in the Lindi area of southeast Tanganyika at 12,711 feet, was abandoned in January 1959 at 13,336 feet. Onshore geological field work continued in 1959. At the end of December a marine seismic survey was in progress off the coasts of Tanganyika, Kenya, and nearby islands.

Kenya

IN KENYA BP-Shell Petroleum Development Co. Ltd. continued stratigraphic drilling in the Lamu coastal area about 80 miles southwest of the Somalia border. Lamu 3 and 4 were completed at depths of 2,504 and 2,284 feet respectively and the company reported a total of 4,138 feet of hole for 1959. Geological field work was conducted in the Lamu area, and also in a new concession area in the Wajir district in northern Kenya. This area covers about 9,500 square miles.

Frobisher Ltd. of Toronto, Can., completed a geological survey of its 8,000 square-mile exploration license in northeastern Kenya, and was to do more detailed work when geological mapping of contiguous holdings in Somalia is finished.

A new exploration license was taken out in 1959 by N. M. Mehta, covering about 5,760 square miles in southeastern Kenya between Voi and the boundary of the BP-Shell license, according to AAPG *Bulletin* 44, No. 7 (1960).

Wire ropes travel hundreds of ton-miles on rotary oil drilling rigs lifting and lowering drill pipe and tools out of and into the hole. On the world's deepest oil well Tuffy Rotary Line handled the longest string of well casing ever run. The final live load totaled 700,000 lbs.

Quickly Available . . . Around the oil world leading oil field supply stores make the ultimate low cost Union Standard Wire Ropes and Tuffy Rotary Lines quickly available.

Ton-Mile Indicator Free

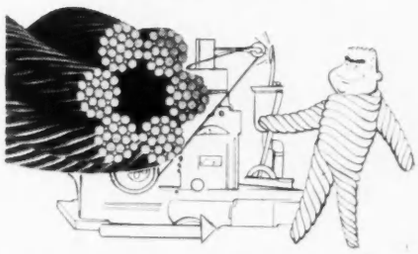
It's quick and easy to figure ton-miles of service with this slide rule chart. Designed for use in following cut-off practice originally developed by Union engineers. Write Union Wire Rope Corporation, 2104 Manchester Ave., Kansas City 26, Missouri.

3-O

Tuffy® Wire Rope Tips

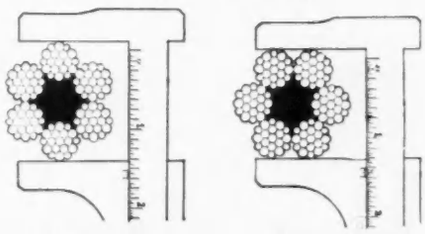
Money-Saving Information on the Use and Care of Wire Rope

Wire Rope is a "Machine" of Moving Parts



. . . and every part must fight destructive forces! A "look inside" a section of wire rope reveals a precision assembly of working parts. They are subjected not only to external and internal stresses, but also to heavy surface pressures and abrading. All these forces may be sustained while the rope is running at high speeds, and abruptly changing direction. That's why different uses require different constructions of wire rope.

How to Measure Rope Diameter



Right Way *Wrong Way*

There's only one right way: Use machinist's calipers, and be sure to measure the **widest** diameter. A slight shift of the rope in the calipers (shown at right above) might cause ordering an undersize rope.

How to Measure Tread Diameter

Easy, and important. Select the smallest sheave or drum to be used with the new wire rope, and measure actual diameter at lateral center (shortest dimension) of tread.

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Somalia

Sinclair Somal Corp. was drilling Merca 1, located about 25 miles southwest of Mogadiscio, at 4,600 feet at the start of 1959. This test was abandoned at 13,118 feet last year. At the close of the year a new location 50 miles north of Merca 1 had been staked at Duddumai 1.

Standard-Vacuum Oil Co. continues exploration on its 11,740 square-mile license located between Sinclair's license and the Ethiopian border. Stanvac did aerial photographic and surface geologic work in 1959, and started a gravity survey in 1960.

Mineraria Somala (Italian interests) obtained additional acreage in extreme northern Somalia and continued its wildcatting program. Darin 1 was a test drilled in 1959 about 90 miles northwest of the previously-abandoned Cotton 1 well. Darin 1 bottomed at 9,806 feet in basement after finding some gas shows. Hordio 1, a wildcat located near Ras Hafun was being drilled at 2,389 feet at the end of 1959, according to AAPG *Bulletin* 44, No. 7 (1960).

Frobisher Ltd. of Toronto, Can., held exclusive exploration rights in 70,000 square miles contiguous with holdings in northeast Kenya. Assignment of the coastal belt and offshore parts of this area to Sinclair Somal was approved by the government.

Ethiopia

Gewerkschaft Elwerath signed a concession agreement in March 1959 and commenced exploration in a large area in Ogaden Province, the easternmost part of Ethiopia. Half of the concession reverts to the government after two years, and another quarter is to be returned after two additional years. Exploitation rights would be granted for 50 years following discovery of oil. Surface mapping, seismograph, gravity, and magnetic work were commenced in 1959.

Somaliland Protectorate

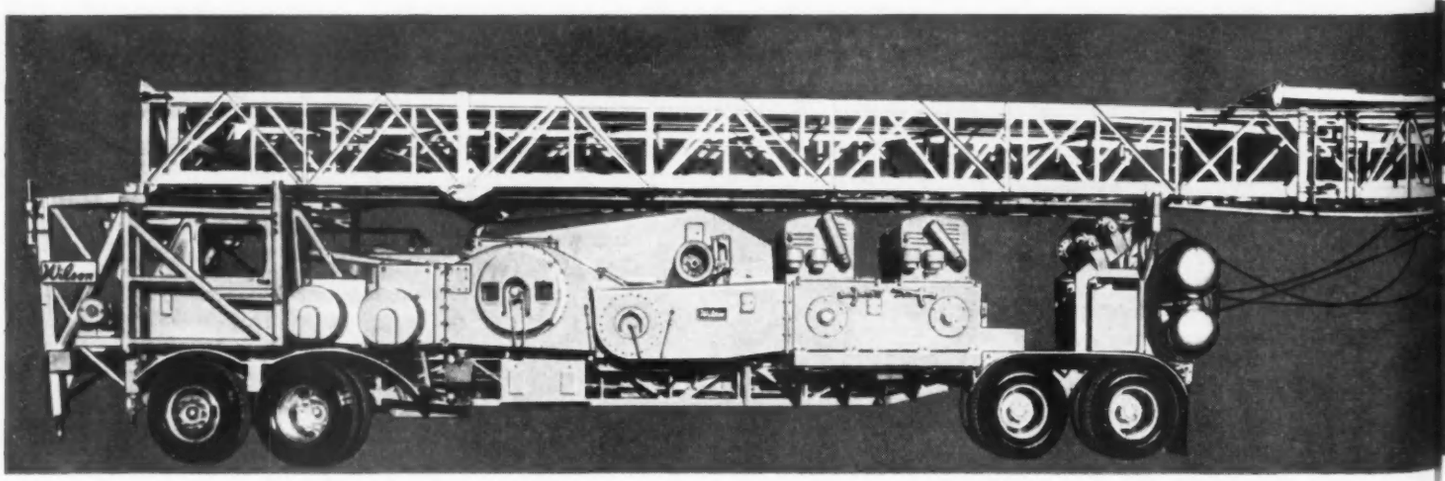
Standard-Vacuum Oil Co. completed three tests at Dagah Shabel and one at Las Dureh in 1959. The Dagah Shabel wells condemned the oil shows which had raised hopes early in 1959. Shabel 1 was completed at 4,500 feet in basement in March 1959. Wells 2 and 3 bottomed at 4,768 and 4,952 feet respectively, and Las Dureh was a slim hole to 796 feet. Biyo Dader was drilled to 3,200 feet by the end of December and was abandoned at 4,842 feet on February 2, 1960. Later, Stanvac ended its 5-year search after spending $5 million in the Somaliland Protectorate.

BP Exploration Co. Ltd. did geological field work in the Berbera-Zeila area, and completed Zeila 1 at 461 feet, Zeila 2 at 610 feet, Zeila 3 at 550 feet, and Berbera 1 at 2,530 feet to check seismic data. Four more stratigraphic holes were to be drilled in the Berbera vicinity in 1960.

Sudan

The Sudan was attempting to develop interest in its oil possibilities and to encourage operators to apply for exploration licenses pursuant to the Petroleum Resources Development Act of 1958. In August 1959 AGIP Mineraria Sudan, composed of Italian and Sudanese government interests was set up to explore for oil on 11 new permits covering about 3,300 square miles. Some of the area is off-

DIAMOND Roller Chain specified . . .



shore in the Red Sea. The permits cover 800 square kilometers each.

General Exploration Co. of California acquired 7 such licenses adjoining those held by AGIP last fall, in the name of General Exploration Co. (Sudan) Ltd. Total area is about 2,100 square miles. Royal Dutch Shell also was granted a permit to do geological work in the Sahara area west of the Nile River and north of 16° north latitude.

Egypt Region of UAR

By mid-1960 the General Petroleum Authority (GPA) of the United Arab Republic had taken strong organizational steps to supervise oil activities in both Egyptian and Syrian regions. Negotiations were in progress between GPA and Pan American International Oil Co. early in 1960 regarding certain western desert areas in Egypt. At midyear, the entire western desert was opened to bids.

New look at western desert. The area involved includes not only the 90,000 square miles north of the twenty-eighth parallel held from 1954 to 1958 by four major U. S. firms headed by Continental Oil Company, but extends 200 miles farther south to parallel 25 (see map). Spectacular

TABLE 1—Crude oil production and development drilling in Egypt in 1959, by companies and fields

COMPANY and FIELD	CRUDE OIL PRODUCTION					Year Discovered	Total Wells Drilled to End 1959	Producing Formation	Oil Gravity (deg. API)	WELLS COMPLETED IN 1959				Wells Drilling End of 1959
	Total Barrels		Barrels Daily		Percent Diff.					WELLS			Total Footage	
	1959	1958	1959	1958						Oil	Dry	Total		
Compagnie Oriental des Petroles d' Egypt (COPE)														
Belayim	9,410,465	9,448,809	25,782	25,887	— 0.4	1955	48†	mid. up. Mio.	22-23°	9	..	9	84,817	4
Abu Rudeis	2,613,651	2,699,348	7,161	7,395	— 3.2	1957	5†	basal Miocene	22°	1	..	1	5,724	1
Feiran	111,745	113,551	306	311	— 1.6	1949	5†	middle Miocene	26°	..	..	..	..	..
Sidri	255,372	.....	700	.....	.....	1959	2	basal Miocene	24-26°	2	..	2	23,028	1
*Anglo-Egyptian Oilfields, Ltd.														
Ras Gharib	6,441,076	7,108,424	17,647	19,475	— 9.4	1955	172	Carb., Mes., Mio.	26°	3	..	3	9,281	1
Hurghada	225,678	222,233	618	609	+ 1.5	1913	139	middle Miocene	22-30°	..	..	..	.....	..
*Anglo-Egyptian Oilfields, Ltd.														
Sudr	1,103,130	1,288,189	3,022	3,529	—14.4	1946	33	Eocene, Miocene	23-24°	..	..	..	.....	..
Asl	1,046,642	1,039,780	2,868	2,849	+ 9.7	1948	29	Eocene	22°	..	..	..	.....	..
Ras Matarma	97,983	77,645	268	213	+25.8	1949	6	Eocene, Miocene	17-18°	..	..	..	.....	..
General Petroleum Company														
Ras Bakr	.....	.....	.....	.....	.....	1958	15	Eocene, Cret.	22-23°	10	1	11	35,863	2
K'reim	.....	.....	.....	.....	.....	1958	6	Eoc., bas. Mio.	17-18°	4	..	4	11,131	1
Total, Egypt	21,305,742	21,997,988	58,372	60,268	— 3.1	....	585	.....	...	29	1	30	169,844	10

*Anglo-Egyptian Oilfields, Ltd.'s properties were "sequestrated" in 1957 and run by the Egyptian government through mid-1959.
†There were 37 producing wells in Belayim, 6 in Abu Rudeis, and 2 in Feiran at the end of 1959. COPE reported 35 of these producers flowing and 10 pumping.

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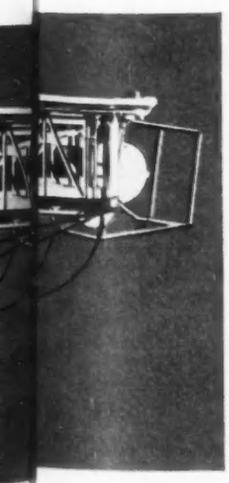

Mogul "42" Winchmobile, built by Wilson Manufacturing Company, Wichita Falls, Texas has a rated capacity of 16,000 feet, using 2½-inch tubing. Thoroughly dependable *power transmission* is required to operate at this depth. That's why Diamond Roller Chains are used exclusively in Winchmobile transmissions. Wilson knows from long experience that Diamond's capacity for shock and peak loads . . . its resistance to wear, and its dimensional stability, contribute substantially to the efficiency and low operating cost of Wilson equipment.

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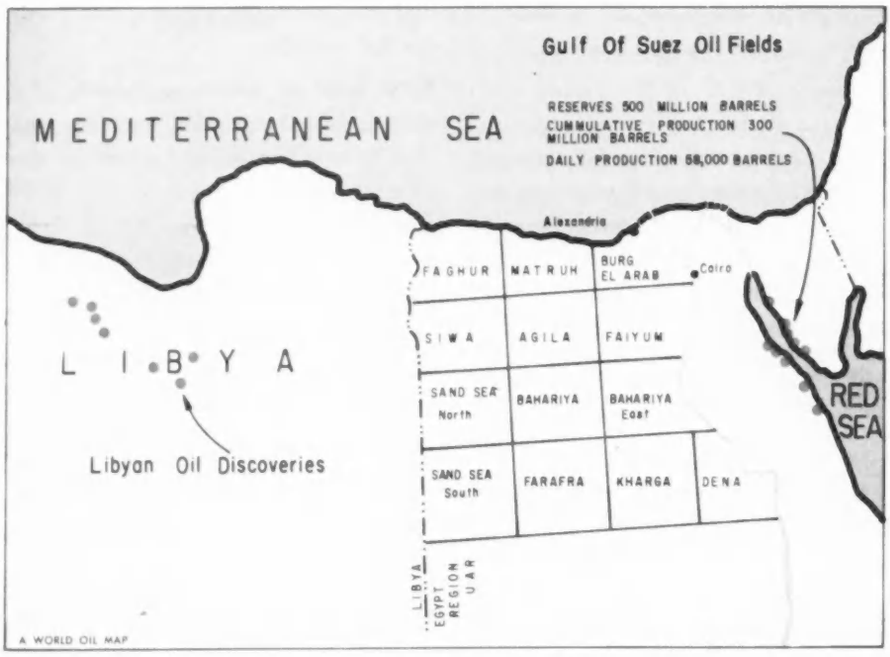


This map shows relationship between Libyan oil fields near the Gulf of Sirte, the large western desert areas opened by the UAR government to bids by private firms, and oil production in the Suez Graben.

recent oil discoveries in Libya make the vast Egyptian Sahara look attractive, despite negative results of the Conorada group's efforts. Geological mapping, reconnaissance gravity and seismograph work uncovered 120 leads, of which 13 were drilled. Drilling located a huge lower Cretaceous basin containing more than 7,000 feet of petroliferous black shale. Some of the terms for western desert concessions were as follows:

- Concessions will be granted according to Articles 50 and 51 of Law 86 of 1956; the Minister of Industry may grant some exemptions to some provisions of Mines and Quarries Law 66 (1953)
- Exploration permits are to be relinquished as follows: one-fourth of the permits in each concession area after three years; 50 percent at the end of six years; and a maximum of 15 permits may be retained after ten years, not including exploration permits converted to exploitation
- Minimum royalty is 15 percent in cash or kind during the first 10 years after the exploitation date, increasing to 25 percent after 10 years
- If the exploitation company formed includes Arab capital, the UAR government is to receive *either* the sum of stated royalties, rentals and taxes, or 50 percent of net profits without stipulating its share as participant in the Arab company. If UAR capital is excluded in the exploitation company, the government may take more than 50 percent of net profits.
- Applicants are encouraged to offer to refine a specific portion of any crude production developed
- Bids were to be received by the Central Minister of Industry in Cairo not later than 12 noon on August 15, 1960. However, with such a huge area involved, it was hoped that the deadline might be extended.

Suez Graben area. Production in Egypt remained restricted to the Suez Graben, where about 500 million barrels of reserves have been proven. Compagnie Orientale des Petroles d'Egypt (COPE) made an important discovery at Sidri 4, on Sinai last year, south of Abu Rudeis. Two wells at Sidri produced 255,372 barrels of 24-26° API gravity crude last year (Table 1). As at Abu Rudeis, Sidri production is from the basal Miocene. If, as appears likely, Sidri is an extension of Abu Rudeis field, the extension will constitute a very important increase in Egypt's reserves.

Ras Bakr field, discovered by General Petroleum Co. (of Egypt) in 1958 about 10 miles north of Ras Gharib field on the Red Sea west shore, is proving to be important. Ten oil wells were completed at Ras Bakr last year, and a 12-inch pipe line was being installed at the end of December. Production began on March 16, 1960, at the rate of 5,650 barrels of crude daily. Kreim field, originally expected to be bigger than Ras Bakr, has proven to be complexly faulted. After completion of five wells in 1959, a seismic survey was underway to aid subsurface interpretation. Kreim field was to go on production this year at the end of July. Hence, crude oil production in Egypt is expected to increase significantly this year, with the newer fields offsetting continuing depletion of the older ones.

The strong rise in Egyptian crude oil output was halted temporarily last year when 58,372 barrels daily was produced, down 3.1 percent from the 60,268 bpd average of 1958 (Table 1).

Drilling is becoming more active. Thirty-one wells, including 29 oil wells and 2 dry holes, were completed in 1959, and 184,964 feet of the hole was cut (Table 2). This compares favorably with 21 completions and 172,912 feet in 1958. In 1960, drilling was being accelerated, and 50 or more wells may be completed in Egypt this year.

Ten development wells were being drilled at the end of 1959, with an additional wildcat being drilled directionally below 8,244 feet by COPE on December 31.

The UAR has an unusual trade arrangement with Yugoslavia, whereby the Yugoslavs import Egyptian crude and in return provide drilling crews and services in the Egyptian oil fields. Two Yugoslav rigs were reported en route to Egypt in mid-1960.

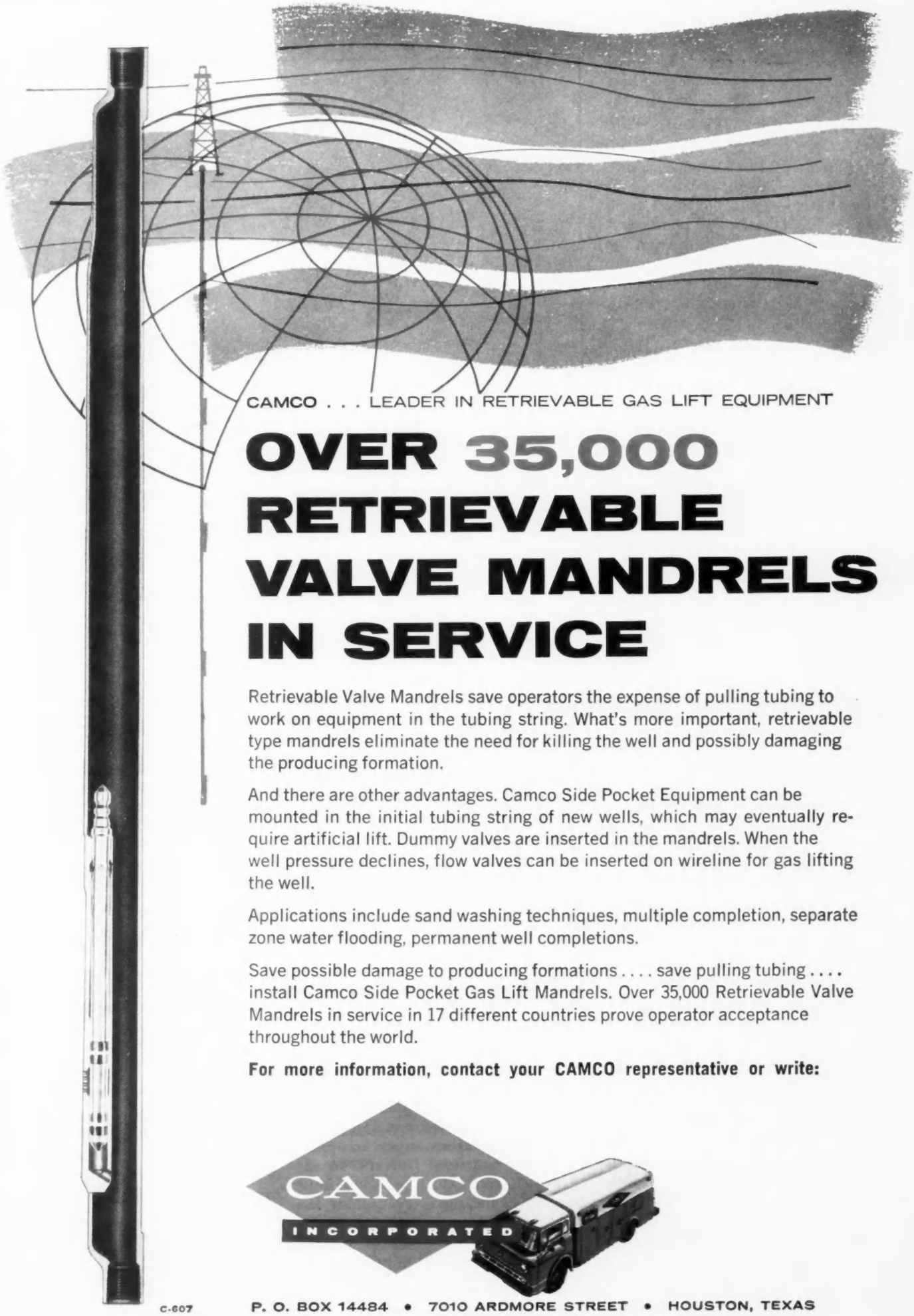
In other exploratory work, General Petroleum Co. reported 21 party-months of seismic exploration and 12 crew-months of gravity work in 1959.

TABLE 2—Drilling in 1959 in Egypt Region of United Arab Republic

	Wells Completed in 1959			
	Wells			Total Footage
	Oil	Dry	Total	
Development and successful wildcat drilling in 1959	29	1	30	169,844
Other wildcats	...	1	1	15,120*
Total, Egypt	29	2	31	184,964*

*Includes 6,876 feet (Abu Durba dry hole) and one directional exploratory well drilling at 8,244 feet at the end of 1959; both by COPE.

New concessions. Reportedly COPE was granted 13 new licenses early in 1960, each covering 38.6 square miles, aggregating 502 square miles. As of April 22, 1960, COPE held 7 exploi-



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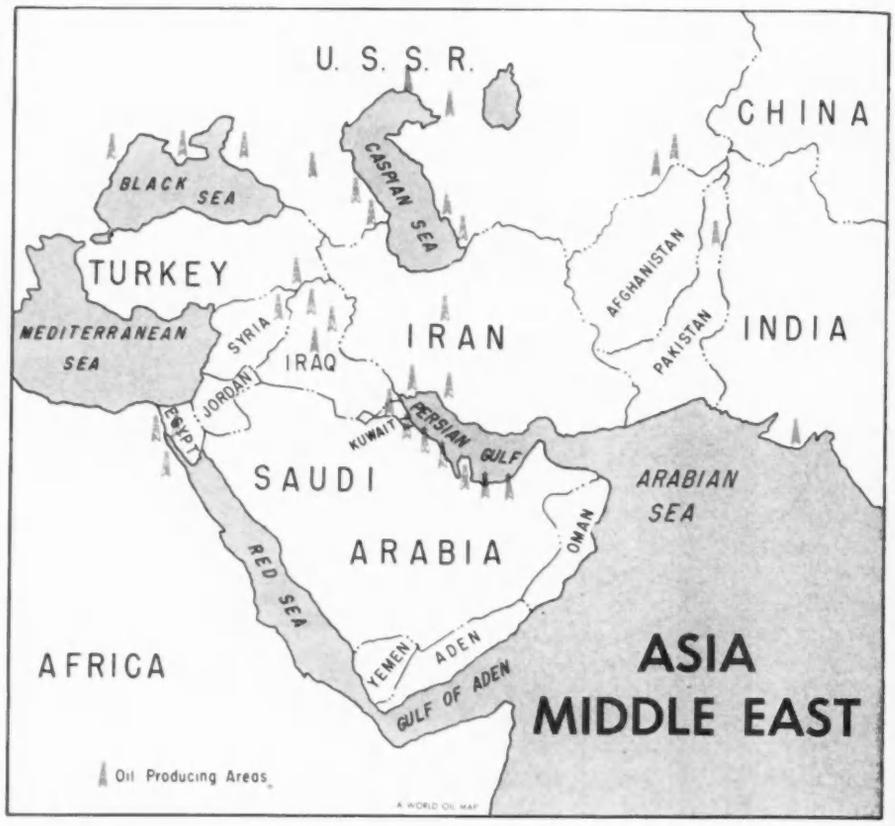
tation permits covering 124 square miles and 19 exploration permits covering 579 square miles. Exploratory drilling on the new permits was to begin at Abu Zunaimah.

Pipe lines. A 12-inch submarine pipe line to move Belayim crude across the Suez Gulf to existing terminal facilities at Ras Gharib was planned. A 16-inch line was also planned, to move crude from the Ras Gharib gathering center to Suez, where loading and port facilities are to be expanded.

Refining. In connection with the new pipe line system, a new distillation unit is planned for 1962 completion at Suez. A new coking plant was also planned, to reprocess residual fuel oil refined from Belayim crude.

Suez Canal. Crude oil shipments via the Suez Canal increased moderately in 1959, with about 87 million metric tons passing northbound through the canal compared to 84 million tons in 1958.



Expansion Continuing in Middle East

EACH YEAR the Middle East develops more fully toward becoming the focal point of the world oil industry, as production rises toward being more nearly commensurate to the enormous crude reserves.

In Iran, the 26/30-inch crude oil pipe line system to move Gachsaran crude to the Kharg island terminal in the Persian Gulf was completed in mid-1960, boosting the field's output capacity to 330,000 bpd. A major gas field was found and developed at Sarajeh, establishing commercial production in central Iran.

Large oilfields were proven offshore in the Persian Gulf in the Neutral Zone and Abu Dhabi, and offshore wildcats in search of similar deposits were under way in Iran and Bahrain.

Onshore, Khurais oil field in Saudi Arabia and Rumaila field in south Iraq have been proven to hold very large reserves. Pipe line and terminal facilities were being expanded in Iraq to provide a daily output of 1,165,000 bpd by 1962. In northern Kuwait, Raudhatain field is now on production, adding from 100,000 to 200,000 bpd to the nation's crude oil yield.

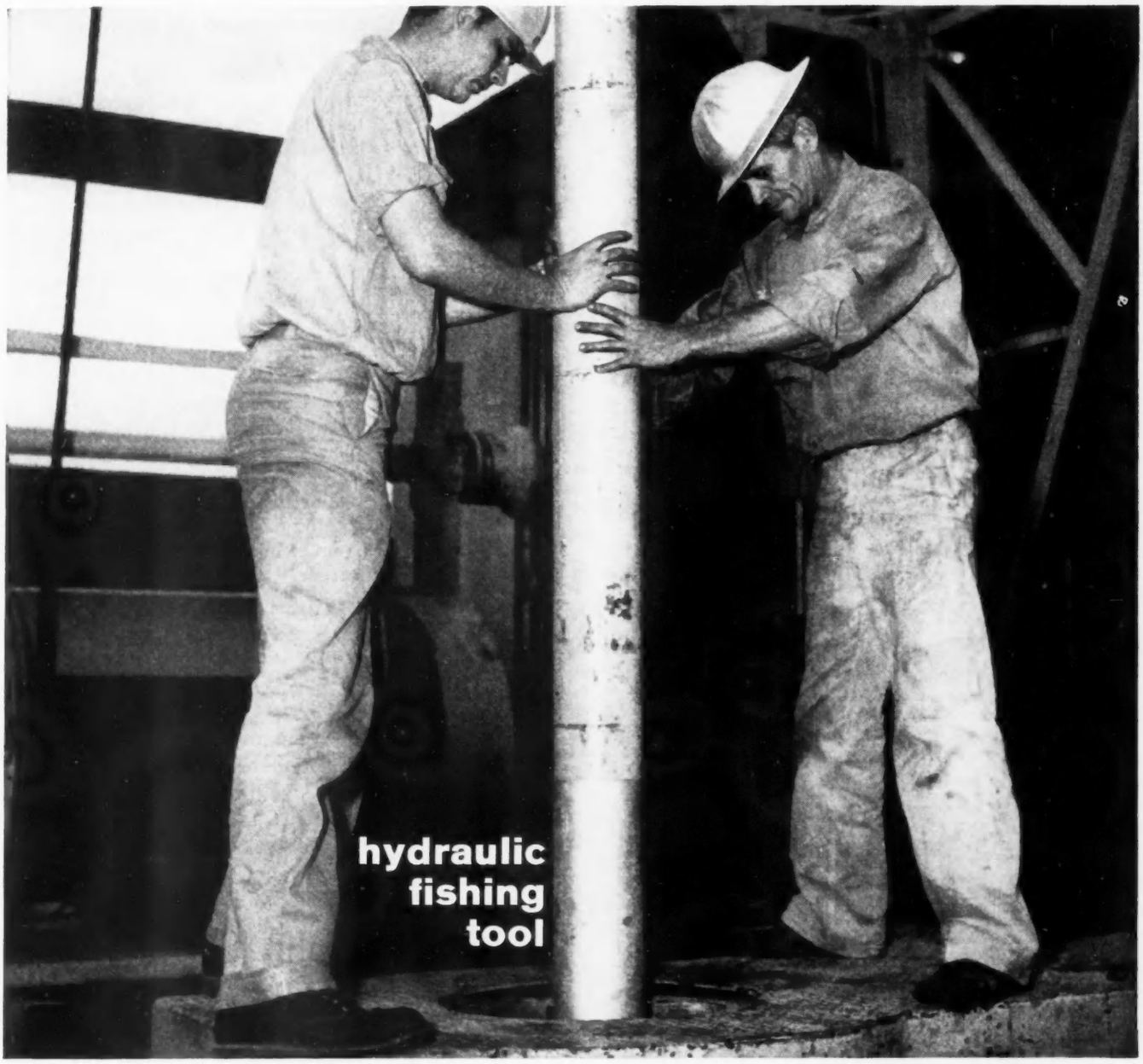
An important new oil field has been found in Kuwait at Minagish. Other important oil discoveries include Ahwaz and Binak in Iran, and Souedie in northeastern Syria. An important gas field was proven in Israel at Rosh Zohr.

Pressure maintenance and secondary recovery programs of enormous magnitude are being developed at Kirkuk in Iraq and at 'Ain Dar and Abqaiq in Saudia Arabia.

Syria Region of UAR . . . second oil field discovered near Iraq border

SYRIA'S SECOND oil field was discovered in 1959, when Concordia, a firm representing West German (Deutsche Erdol A G) interests, struck an upper Cretaceous limestone horizon in an interval from 5,620 to 6,348 feet. Souedie 1, the discovery well, is located in extreme northeast Syria about 8 miles southwest of Karatchok field and about 4 miles from the Iraq border. The discovery well bottomed at 6,670 feet. A confirmation test, Souedie 2, east of the discovery, was drilling below 3,445 at the end of the year, and by mid-1960 had encountered the reservoir 131 feet structurally higher than the first well.

Concordia was working with three rigs at the end of 1959. Future work



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TYPICAL MECHANICAL PROPERTIES
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Tensile Str. 1000 psi	**Yield Str. 1000 psi**
As Rolled 192	As Rolled 147
Annealed 119	Annealed 99
Hard. & Temp.[a] ..... 150[c], 220[d]	Hard. & Temp.[a] ..... 130[c], 200[d]
Hardness (Brinell)	**Impact Str. ft.-lb.**
As Rolled 380	Izod. Hard.
Annealed 240	& Temp. ..... 73[c], 16[d]
Hard. & Temp.[a] ..... 310[c], 445[d]	

[a] Properties after heat treatment are based upon oil quench and 1-in. round bars.
[c] Tempered at 1200° F [d] Tempered at 800° F

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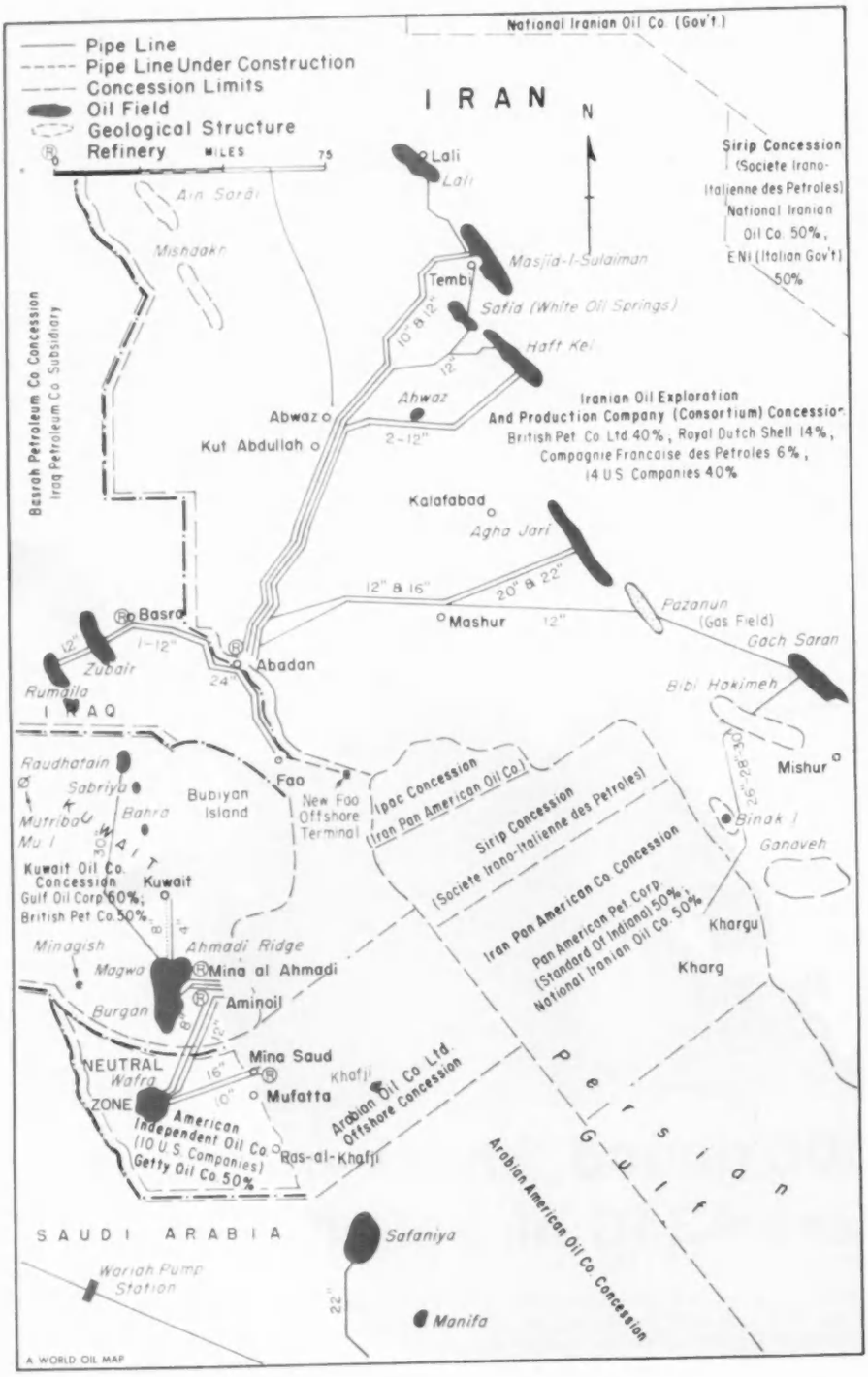

Rapid development of the upper Persian Gulf area's oil resources took place in 1959 and 1960. Arabian Oil Company found its Khafji field 37 miles offshore in the Neutral Zone. Crude oil, productive depths, and 6,000-bpd flowing rates were similar to Safaniya's. In Iraq, Rumaila field has been greatly extended in recent years, and new facilities were being built to increase the South Iraq fields' capacity to 450,000 bpd. In Iran important wildcats were being drilled in IPAC's and SIRIP's concessions. New oil fields were established by the Consortium at Ahwaz and Binak. The 26/30-inch pipe line system to move 330,000 bpd of Gachsaran crude to Kharg Island was being completed in mid-1960.

SYRIA REGION OF UAR

was to be concentrated on development at Souedie field, which was tentatively evaluated at 150 million barrels on the basis of the two wells. Concordia is expected to relinquish some of its 5,400-square-mile concession area. A joint enterprise composed of Concordia interests and the U A R government may be established for development and operation of the new field.

Concordia finished three dry wildcats last year, Cheikh Sollakh 1 at 11,394 feet in lower Cretaceous; El Barde 1 at 10,909 feet in upper Permian, and Kamichlie 1 at 8,776 in Paleozoic. Two new wildcats were drilling as of mid-1960. Tschembe 1, located 65 miles south of the Turkish frontier and 10 miles west of the Iraq border, was at 9,350 feet in lower Cretaceous; and Toueman 1, located 40 miles still farther south along the Iraq border, was drilled at 6,972 feet by midyear. Concordia drilled about 38,000 feet of hole last year.

Negotiations continued in 1960 between the U A R government and the Menhall-Atlantic group, on whose concessions Karatchok field was discovered in Cretaceous limestones at about 6,500 feet in 1956. Operations at Karatchok were being conducted by the General Petroleum Authority (GPA) of the U A R government. Four rigs were taken over at Karatchok, two of which had been leased by the government to Menhall-Atlantic. Apparently the company is to be compensated and GPA will operate the field.

At least seven wells had been drilled in Karatchok by the end of 1959. Additional drilling was budgeted, and a small topping plant, to process about 4,000 bpd, was being erected at Kamichly, near the field. Among other purchases in mid-1960, GPA ordered a sizable quantity of drillstem-testing tools.

The 20,000 bpd refinery at Homs along the IPC pipe lines near the coast has been completed. Late in 1959, GPA invited bids for construction of a 325-mile products pipe line system. There were to be three 6-inch pipe lines from Homs; one to Aleppo, one to Damascus and the third to Lattakia.

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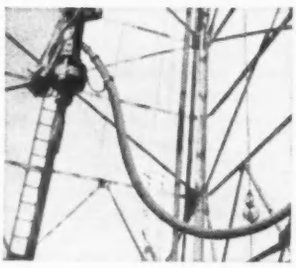

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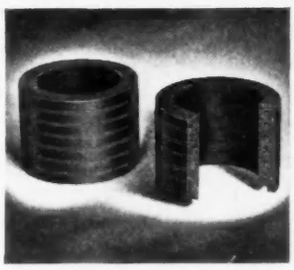

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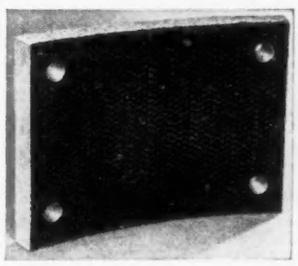

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Yemen Region of UAR

THE ONLY new activity reported from Yemen in 1959 and 1960 was acquisition of a 10,000-square-mile concession by American Overseas Investment Co., headed by W. Angie Smith III. The area involved is part of the Red Sea coastal Tehama strip and offshore waters.

Russian, Czech and/or Red Chinese technicians were believed to be assisting in mapping Yemen and evaluating mineral resources.

Yemen is associated with the United Arab Republic by treaty alliance.

Bahrain . . . production up 10.8%

BAHRAIN'S 1959 crude production totaled 16,473,378 barrels, an average of 45,132 bpd and an increase of 10.8 percent over 1958.

In June 1960 an offshore wildcat test at Fasht al-Jarim, a shoal about 15 miles north of Manama which is on the north shore of Bahrain Island, was announced. Drilling was expected to be underway by the end of 1960.

At the end of 1959, Bahrain Petroleum Co., Ltd., had 148 flowing oil wells on production and five shut-in oil wells. Five gas wells were providing gas for pressure maintenance.

Drilling again was sharply curtailed on the island. No development wells were drilled in 1959, and only one wildcat was completed. Buri 1, spudded in the northwest part of the island in 1958, was dry at 7,675 feet.

Sitka refinery averaged capacity runs of 188,900 bpd in 1959. Total daily charging capacity of the refinery is listed as 186,500 bpd.

Production and Drilling in Bahrain

Year	Crude Oil Production in Barrels	Daily Average in Barrels	WELLS COMPLETED				
			Oil	Gas	Dry	Total	Footage
1959	16,473,378	45,132	..	..	1	1	7,675
1958	14,873,111	40,748	2	..	1	3	5,535

Production Wells in Bahrain in 1959

OIL WELLS				GAS WELLS			Total Wells Producing	Total Wells Shut In
Flowing	Pumping	Shut In	Total	Flowing	Shut In	Total		
148	....	5	153	5	...	5	153	5

The Consortium of oil companies operating in South Iran completed laying undersea pipe line from Ganaveh to Khargu Island late in 1959. The Gachsaran-Kharg 26/28/30-inch pipe line consists of two parts. The first segment from Gachsaran to Ganaveh (71.4 miles) is overland; the second, from Ganaveh to Kharg Island via Khargu Island is under the Persian Gulf. Here 20 miles of pipe is laid out ready for the pull to Khargu. This system has an initial design capacity of 330,000 bpd with gravity flow from Gachsaran (elevation 2,215 feet) to the Kharg Island tank farm (elevation 200 feet). **See Page 190 for details.**

Iran . . . some lost ground regained

IRAN'S OIL INDUSTRY made phenomenal strides in 1959 and 1960, regaining some of the ground lost to Kuwait and Saudi Arabia during the nationalization period (1951-54). Iranian Oil Exploration and Producing Co. (IOEPC), completed its oil discovery at Ahwaz 6 and another at Binak, in South Iran.

National Iranian Oil Co. (NIOC), established significant oil and gas reserves at Sarajeh in central Iran, and in mid-1960, had set a Christmas tree on Alborz 8, near Qum. Productive capacity of Naft-I-Shah field on the Iraq border was boosted.

Encouraging shows were encountered in offshore wildcats drilled in the upper Persian Gulf by Societe Irano-Italienne des Petroles (SIRIP) and Iran Pan American Oil Company (IPAC), on these firms' new concessions.

In addition to important gains being made in exploration and production, rapid and significant pipe line developments took place, to boost future oil exports from South Iran and also to fulfill fast-growing domestic demand in the interior for petroleum products and natural gas.

Consortium activity. Crude oil production by IOEPC, operating for 14 U.S. companies, British Petroleum Co. Ltd., Royal Dutch Shell and Compagnie Francaise des Petroles (a group

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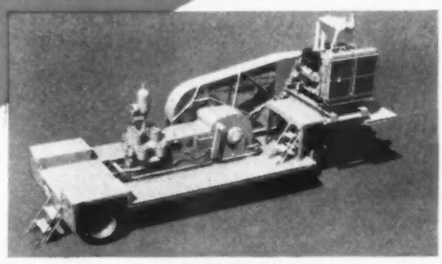
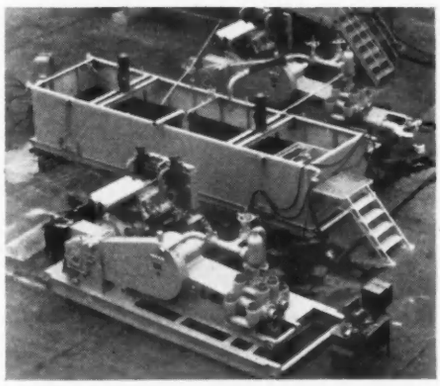


One of 12 trailer-mounted MM-200 pumps for one customer.



Two MM-300 pumps being assembled for testing.

Power pumps that deliver a high pressure punch — Ideco builds them in twelve sizes, duplex and triplex, from 200 to 1250 H.P.

These all-steel pumps feature precision-built power ends and streamlined one-piece fluid ends which work together as a tough team to help you show more profit in today's competitive market.

Ideco pumps are a product of the application of years of engineering experience by men who really know pumps. Fabricated all-steel design assures minimum vibration . . . heat treated pinion shaft and Falk herringbone main gear can be reversed for double life . . . double-row Timken tapered roller bearings assure durability. Threaded valve pot covers speed valve servicing and reduce crew work. Gamma ray and strain gauge tests prove the strength of every part.

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known generally as the Consortium), amounted to 923,000 barrels daily in 1959. Last year's total (Table 1) amounted to a 12.4 percent increase compared to 1958, when 821,000 barrels daily were produced in south Iran. Production in 1950, the last pre-nationalization year, was 661,438 bpd.

Agha Jari field continued to lead other Iranian fields in production by a wide margin last year, yielding almost 600,000 barrels a day (Table 2). Gachsaran field, though it has enormous crude oil reserves, was still restricted to 59,000 barrels daily last year by limited oil-handling facilities. These restricting factors, however, are being eliminated. With the exception of Naft Safid, all south Iran fields improved on their 1958 outputs last year. Masjid-i-Sulaiman, the oldest oil field, increased its output abruptly from 37,000 bpd in 1958, to 45,000 in 1959.

New production and pipe line facilities for Gachsaran field were stressed in 1959. They were essentially completed in 1960. The addition of a second production unit in Gachsaran increased the field's productive capacity to 290,000 bpd as of December 31. Development drilling in 1959 increased its potential to 370,000 bpd by the year's end.

Crude oil production in south Iran during the first five months of 1960 averaged about a million barrels daily. It appeared that the annual boost of about 100,000 barrels daily noticed in Iran during recent years was continuing in 1960, despite the world crude oil over-supply situation. Average production in September 1959 also averaged more than a million bpd.

Drilling was active in 1959 (Table 2), with 11 wells completed during the year and 7 more being drilled at the end of December. Seven new producers accounted for a total potential of 150,000 bpd. Agha Jari 54 was completed for 30,000 bpd. Agha Jari 55 was completed as an observation well. Well 56 established potential oil production in the deeper Cretaceous limestones, below the Asmari limestone field pay. Wells 57, completed in December, and 58, reported drilling at the end of 1959, continued the Agha Jari development program.

At Gachsaran, Well 23 was completed for 14,000 bpd; Gachsaran 24, one of the world's most prolific wells, was potentialed at 30,000 bpd. Gachsaran 20, 21 and 22 were completed for lesser rates, after low permeability was encountered in the field pay. Wells 25, 26 and 27 were drilling at the end of December.

Two wildcat wells were completed, culminating long, drawn-out efforts against severe obstacles. Ahwaz 6, scene of a violent blowout and a prolonged firefighting ordeal in mid-1958, was drilling at 13,100 feet at the start of 1959. It was deepened to 13,210 feet in Cenomanian (mid-Cretaceous) in January, plugged back to 8,725 in the Asmari horizon and completed in May 1959 as an oil producer. This is Iran's deepest well as of early 1960. Tests in April 1960 varied from 6,141 to 6,852 bpd.

The other discovery completed in south Iran in 1959 was Binak 1, on the Kuh-i-Bang structure northwest of Ganaveh, about 20 miles inland from the Persian Gulf. Reported drilling at 4,199 feet at the start of 1959, the well was hampered by high-pressure salt water flows and fishing jobs, but bottomed at 10,822 feet on July 30, 1959. Tests of a Cretaceous pay zone commenced on October 16, and the well flowed from 4,000 to 6,000 bpd. Oil tests of the Cretaceous and of the Asmari limestone were to continue.

Mand 2, a wildcat at Kuh-e Mand on the Gulf south of Bushehr, was drilling at 5,550 feet at the end of 1959. A fishing job was reported later. Suru 1, located near Bandar Abbas in the most southeasterly part of the Consortium area, was drilling in April 1960.

Exploration remained vigorous as indicated by the intensive wildcatting. Geological surveys were conducted in the foothills and along the Zagros Mountain front near the Iraq border, and in certain Persian Gulf islands, including Qishm, Hindurabi, Kish and Shu'Aib. Mapping of the Mishdakh, Pazanan, Lishtar, Kheyrabad, Garangan, Busgan and Kuh-e Ircheh structures was continued.

A gravity survey was conducted from the Hendijan River south to the Mand River, covering flat land between the Kuh-e Bang and Kuh-e structures and the nearby mountain front area. Gravity coverage was also acquired in the plains areas near Bandar-e Lengeh, near Bandar Abbas, and on Qishm Island.

Another seismic party was added in September. Reflection seismic work continued on the Ahwaz trend. A gravity lead near the mouth of the Hendrijan River was checked with seismograph, and a reconnaissance reflection line was shot from the Ahwaz trend to Abadan. Refraction surveys

TABLE 1—Summary of Crude Oil Production and Drilling in Iran in '59

AREA	CRUDE OIL PRODUCTION				WELLS			
	Total Barrels		Barrels Daily		Producing, End 1959	Completed in 1959		Drilling, End 1959
	1959	1958	1959	1958		Wells	Footage	
Consortium Area (South Iran)	336,895,000	299,665,000	923,000	821,000	89	12	115,281	7
Outside Consortium Area	1,914,853	1,860,712	5,246	5,098	4	4	58,360	6
Total	338,809,853	301,525,712	928,246	826,098	93	16	173,641	13

TABLE 2—Production and Drilling in South Iran in 1959

FIELD	Wells at End of 1959			Wells Completed in 1959		Crude Oil Production in 1959		
	Total	Producing	Drilling	Workovers	New Wells	Barrels Daily	Total Barrels	Percent Change from 1958
Agha Jari	48	33	2[1]	..	4	599,000	218,635,000	+19.1
Haft Kel	48	20	..	..	..	150,000	54,750,000	+ 4.2
Gachsaran	24	13	3	..	5	59,000	21,535,000	0.0
Naft Safid	29	17	..	1	1	55,000	20,075,000	— 8.3
Masjid-i-Sulaiman	257	31	..	2	..	45,000	16,425,000	+21.6
Lali	15	5	..	..	..	15,000	5,475,000	—16.7
Ahwaz	7	1	..	..	1	[2]	..	..
Binak	..	..	1	..	..	..	..	..
Mand	..	..	1	..	..	..	..	..
Total	428	120	7	3	11	923,000	336,895,000	+12.4

[1]Includes one test rigging up. [2] 18,487 barrels produced on tests not included in totals.

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NOTE: Magnetic multishot surveys can be made either on wire line or by go-deviling into a non-magnetic drill collar and making the survey as the pipe is pulled out of the hole. Surveys can be made from vertical to the highest angles encountered in drilling. Sperry-Sun crews are available through all sales offices for surveys in the United States and Canada.

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60-2

continued between Pazanan and Gachsaran. Helicopter support of crews is proving very effective in rough terrain in Iran.

Topographic surveys were made along the Gulf coast from Bandar-e Lengeh and Kangan. Similar surveys of the Khuzistan plains were being made at the end of 1959, in a cooperative effort between the Consortium and the National Cartographic Center.

IOEPC conducted a total of 13 geological party-months and 28 geophysical crew-months last year.

Pipe line work paralleled the increase in Gachsaran's productive capacity. The Gachsaran-Kharg island production and 26-28-30-inch pipe line system entered operation in mid-1960.

The 71.4 miles of onshore pipe line from Gachsaran to Ganaveh on the coast was completed in September. By December 17, the 19-mile pipe pull from Ganaweh to Khargu Island in the Persian Gulf had been completed. This segment of pipe lies in Persian Gulf waters as deep as 160 feet and its laying represents an unusual technological feat (PIPE LINE INDUSTRY, April 1960, 40-42). An additional three miles of submarine line has been laid from Khargu to crude oil storage and marine terminal facilities built on Kharg Island.

This system has an initial design capacity of 330,000 barrels of crude oil per day, with gravity flow from Gachsaran (elevation 2,215 feet) to the Kharg Island tank farm (elevation 200 feet). The tank farm has a crude oil storage capacity of 2,728,000 barrels. A four-berth jetty built in 60 feet of water and designed to handle the largest tankers afloat; 36-inch loading lines, and other port facilities were being built at Kharg at the end of 1959.

A new natural gas pipe line (222-mile, 10-inch) is projected between Gachsaran oil field and a fertilizer plant being built at Shiraz.

Exports were boosted in 1959, when 1,263 tankers loaded 213 million barrels of crude, compared with 1,215 tankers which took on 179 million barrels of crude in 1958. Of the 1959 tanker total, 1,253 loaded at Bandar Mashur and 10 at Abadan. Also, 752 tankers loaded products at Abadan. An additional 594,000 barrels of storage capacity was added in south Iran last year, bringing the total to 4.5 million barrels.

More refining was done in south Iran last year. An average of 322,000 barrels daily was charged at Abadan in 1959, compared with 310,000 barrels in 1958. Refining rates remained high in mid-1960. An average of 340,000 bpd was processed at Abadan in May 1960.

Natural gas utilization at the Abadan refinery was boosted last year upon completion of new pipe line facilities. The gas supply from Agha Jari field was increased from 42 million to 63 million cubic feet daily.

TABLE 3—Drilling and Production in Iran Outside Consortium Area in 1959

Drilling

All by National Iranian Oil Company (NIOC) or by firms composed jointly of NIOC and private interests.

[1]Company and Field or Area	[2]Type of Drilling	Wells and Footage Drilled in 1959		Wells Drilling, End 1959
		Wells	Footage	
NIOC alone:				
Naft-I-Shah	Dev.	2	3,630	.....
Sarajeh	Dev.	1	21,618	2
Alborz S	Explo.	.....	9,873	1
Sorkheh	Explo.	1	1,896[3]	.....
Gorgan[4]	Explo.	.....	5,000	1
Total, NIOC alone	.....	4	42,017	4
NIOC Jointly With:				
IPAC	Explo.	.....	9,355	1
SIRIP	Explo.	.....	6,988	2[5]
Total	.....	4	58,360	7

Production

(All in Naft-I-Shah field; all by NIOC.)

ITEM	Amount or Number
CRUDE OIL	
Production Barrels	1,914,853
(Barrels Daily)	5,246
Crude Oil Producing Wells at End of 1959:	
Flowing	4
Pumping	.....
Shut In	4
NATURAL GAS	
Production in 1959	
Total, Million Cu. Ft.	1,353
Cubic Feet Daily	3,706,849
Percent Utilized	60
Percent Flared	40

[1] Abbreviations—NIOC: National Iranian Oil Co.; IPAC: Iran Pan American Oil Co.; SIRIP: Societe Irano-Italienne des Petroles.
[2] Development or exploratory.
[3] 1959 footage only. Dry hole total depth was 6,233 feet.
[4] Gorgan[1] stratigraphic hole.
[5] Includes onshore test temporarily suspended at end of 1959.

TABLE 4—Refining in Iran in 1959

Area, Refinery Location, and Company Operating Refinery	Plant Capacity (Barrels Daily)	Crude Runs to Stills (Barrels Daily)
a. Consortium area (South Iran), Abadan, Iranian Oil Refining Co.	412,000	322,000
b. Outside Consortium Area, Kermanshah, National Iranian Oil Co.	3,000	2,279
	415,000	324,279

Also, sulfur recovery is being pushed both at Abadan and in the oil fields to increase the supply of sulfuric acid needed in Abadan's process streams.

Reserves. Despite recent drilling successes, south Iran crude reserves have recently been downgraded somewhat. Recovery factors for the highly fractured limestone reservoirs are being more conservatively calculated. A figure for south Iran attributed to IOEPC is 17.75 billion barrels as of the end of 1959. An NIOC geologist rates Gachsaran field at 12 billion barrels, and Agha Jari at 7 billion. Another NIOC estimate rates all Iran at 35 billion barrels.

Activities outside south Iran. NIOC, the government agency which administers the Iranian oil industry, operates actively in central Iran and owns half interests in the partnership firms SIRIP, IPAC and IRCAN, was very active in 1959 and 1960.

Exploration in central Iran succeeded in 1959, when NIOC's second test of the Sarajeh structure tested 331 bpd of 53.7° API gravity crude from the interval 8033-38 feet in the Asmari. Gas/oil ratio was 16,883 to 1. A deeper reservoir tested 441 bpd of 53.5° API gravity crude from 8,545-86 feet, with GOR of 14,000/1. Open flow (gas) potential in the lower zone was 40.5 MMcf daily.

Two wells were shut in at Sarajeh at the end of 1959, and another was being drilled. Productive area at Sarajeh is estimated at 29,000 acres. Structural closure is estimated at 3,000 feet. NIOC estimated gas reserves at Sarajeh at 7 trillion cubic feet and light condensate reserves at 400 million barrels.

NIOC conducted 5 geological and 24 geophysical party-months in 1959 in various areas, including Semnan, Yezd, Sarajeh, Isfahan and Shiraz. About 5,000 feet of stratigraphic drilling was done at Gorgan, southeast of the Caspian Sea, and this activity was being intensified as of mid-1960.

Productive potential of Naft-i-Shah oil field was raised to 19,000 bpd last year upon completion of two new wells and repair of the old one. Iran Oil Company, NIOC subsidiary operating Naft-i-Shah field, completed N-i-S 3 at 3,062 feet, flowing 6,052 barrels of 44.5° API gravity crude daily from the Kalhur limestone (Oligo-Miocene) with a GOR of 694. Four wells were flowing at the end

of 1959, with four others shut in. About 90 million barrels has been recovered from Naft-i-Shah (including the Iraq portion known as Naft Khaneh), and ultimate recovery is expected to be 240 million barrels of crude.

Crude oil production at Naft-i-Shah averaged 5,246 barrels daily last year, up 2.9 percent from the 1958 net yield of 5,098 bpd. Unlike 1958, when some surplus topped crude was returned to the formation, almost all of the 1959 production was absorbed by nearby internal markets. NIOC's 1959 drilling and production are detailed in Table 3.

As of June 6, 1960, Alborz 8 had bottomed at 11,525 feet, with casing set at 10,697 feet; the well was being tested. Sarajeh 3 had reached 12,013 feet, with casing set at 9,396 feet; Sarajeh 4 was undergoing tests, with casing set at 9,241 feet and total depth, 11,825 feet. In the Caspian Sea area, Gorgan 3 and 4 had reached depths of 3,120 and 1,400 feet respectively.

Pipe line outlets for increased crude, products, and natural gas were developing rapidly in interior Iran. A new 106-mile, 4-inch line was completed on May 31, 1960, from Naft-i-Shah pump station No. 2 to the Kermanshah refinery. The Trans-Iranian products pipe line system is also being expanded from Tehran northwestward 200 miles to Resht and northeastward 236 miles to Shahroud.

Following its important discovery, NIOC made plans to move Sarajeh oil and gas, first to Teheran (where a new refinery may be built) and later to the industrial town of Isfahan. Fuel oil shipments from Abadan are to be thus displaced.

In May 1960, NIOC announced the signing of a contract with the Italian group SNAM Projetti, pipe line branch of Ente Nazionale Idrocarburi (ENI), for preliminary survey and design of a 90-mile natural gas line from Sarajeh to Teheran. The line was expected to be 20-inch. Another 65 miles of distribution network in Tehran was said to be involved in the deal also.

SIRIP activity. SIRIP's first offshore well on its concession near the head of the Persian Gulf was spudded on August 30, and reached 6,371 feet at the end of December. Good oil shows were found. On drillstem tests, 20 stands of oil each were recovered from a Tertiary zone at about 7,300 feet, and a Cretaceous horizon at about 9,200 feet. This test had reached 10,493 feet by June 6.

SIRIP was also drilling its first onshore well, located in the remote Zagros Mountains area. At the Sequta location, water supplies were inadequate, and the well is being air drilled. The test was spudded on November 9, but was shut down at 615 feet at the end of December because of severe weather. A depth of 4,825 feet was reached on June 6.

SIRIP conducted 32 geological and 17 geophysical crew-months of exploration last year. The Mokran structure, and the Behbahan-Gachsaran and Zagros regions were studied.

IPAC completed gravity and seismic work last year, and spudded its first offshore Persian Gulf test on October 11. This test (No. A1) had reached 9,355 feet by the year's end and a total depth of 13,152 feet in May 1960, with 7-inch casing set at 12,912 feet. The well was being tested. It

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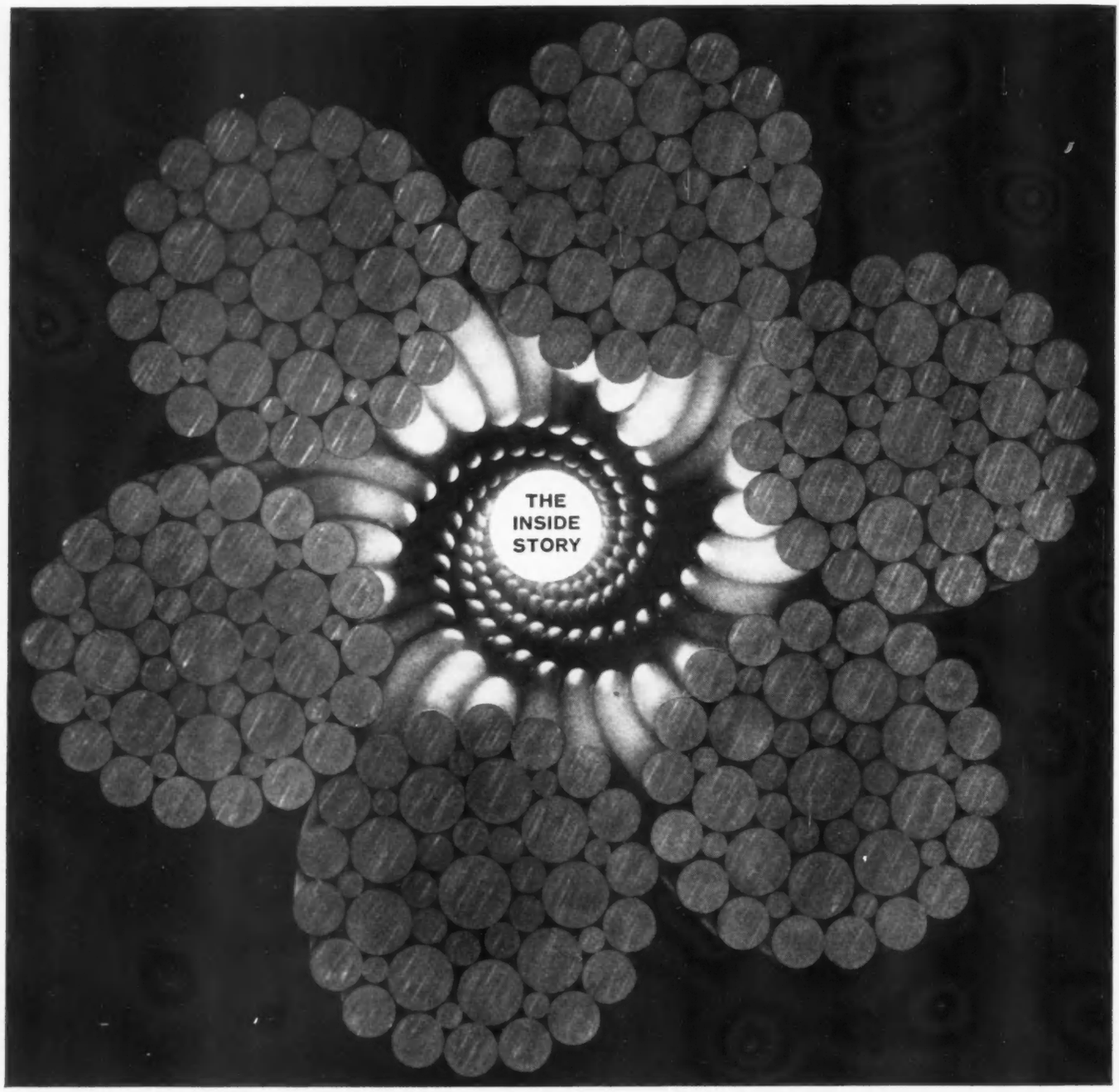

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is located 58 miles offshore in the northwest portion of the Gulf, in 126 feet of water.

IPAC's second test, involving an entirely different prospect, was spudded in 1960, and had reached 4,006 feet on June 6. The B-1 location is 22 miles south of Kharg Island in 146 feet of water.

Government oil income. The Iranian government received $262,486,481 in oil revenues from the Consortium last year, about $15 million more than in 1958.

Iraq . . . higher output reflects political stability

IRAQ'S OIL INDUSTRY forged ahead to higher outputs in 1959 and 1960. Renewed confidence in the nation's political stability was evidenced by large expansion programs underway. Jambur field entered production last year, and new, deeper pay zones were found in Bai Hassan field.

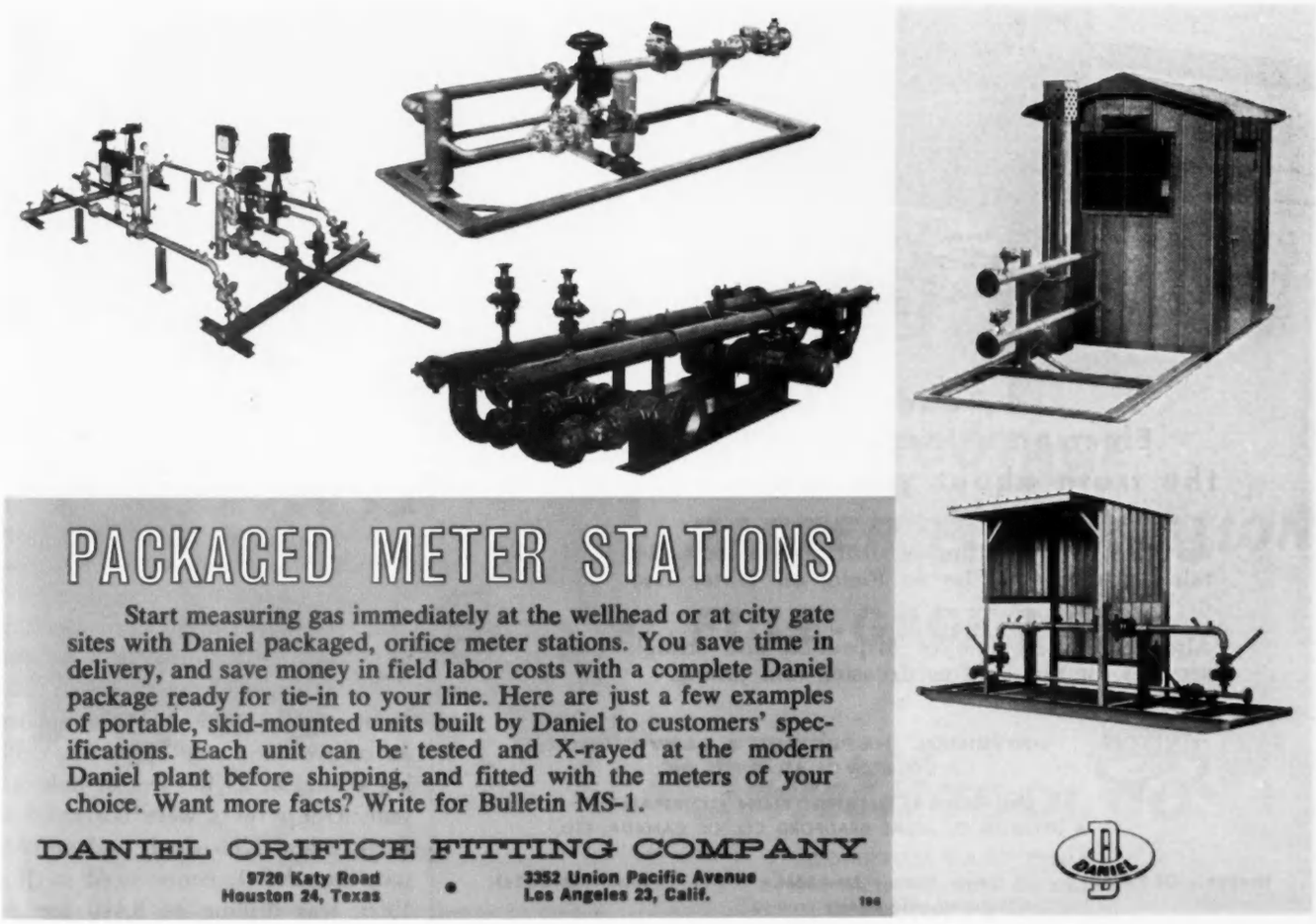
By mid-1960, reports told of a huge new secondary recovery waterflood program for Kirkuk field, an outgrowth of exhaustive engineering studies discussed in last year's report (WORLD OIL, August 15, 1959, pp. 186-187). Iraq's crude oil reserves were being upgraded in early 1960, largely due to a more optimistic reevaluation of Rumaila field.

Crude oil production increased to 311,311,000 barrels, an average of 852,907 barrels per day, representing an abrupt 17 percent increase compared with the 1958 average of 729,047 bpd (Table 1). Drilling footage increased from 88,529 feet in 1958, to 138,459 last year. There were 23 completions in 1959 compared to 13 in 1958, and 11 wells were actively drilling at the end of each of the past two years, with an additional test being suspended at the end of 1959. Nineteen wells were completed during the first half of 1960, including 7 at Kirkuk field and 4 in Rumaila field. At the end of 1959, there were 134 wells producing in Iraq, compared to 120 a year earlier.

Concessions. By the end of December, Iraq Petroleum Co. Ltd. (IPC), had agreed to relinquish 100,000 square miles and negotiations with the government continued. Up to mid-1960, IPC and its affiliates, Basrah Petroleum Co. Ltd. (BPC), and Mosul Petroleum Co. Ltd. (MPC), held concessions on the entire country excepting the offshore area at the head of the Persian Gulf and the Chia Surkh (Khanaqin) area on the Iranian border.

Active exploration continued, providing additional coverage. IPC companies conducted 30 crew-months of geological survey, 66 party-months of seismic reflection and 3 crew-months of refraction work in Iraq in 1959, in addition to the wildcatting described later.

IPC increased its crude oil yield last year by a larger proportion than MPC did, despite IPC's larger previous production rate. Crude oil output aver-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aged 568,118 bpd, 20.8 percent more than the 1958 IPC figure (470,329 bpd). Production in 1959 increased from 523,570 bpd in January to 616,540 bpd in December. Crude oil output during the first four months of 1960 averaged about 635,000 barrels daily.

Jambur field, located about 20 miles south of Kirkuk field, went on production for export in August 1959. The December production rate was 14,230 bpd. Four wells were on production at Jambur, augmenting the 56 wells being produced at Kirkuk at the year's end.

In March 1960, a $1.4 million contract for the design, supply and construction of a crude oil sweetening plant to handle 250,000 barrels daily was awarded to Foster Wheeler Corporation. The plant is to be built at Kirkuk. It is expected to be the largest crude oil thermal stabilizer unit of its type in the world.

IPC completed two wildcats last year and two more were drilling at the year's end. No discoveries were announced, with the exception of the new deep zone at Bai Hassan. Gilabat 1, spudded in October 1958, was abandoned in September 1959, at 6,547 feet. Gilabat 2 was spudded last December and reached 2,004 feet by the end of the year. Gilabat is about 60 miles southeast of Jambur field. Pulkhana 5, located between Jambur field and Gilabat, was commenced in August 1956, and was finally abandoned at 9,500 feet in August 1959. Pulkhana 6 was spudded last November and reached 1,780 feet by the end of December.

Pipe line expansion was proceeding rapidly in the IPC and MPC areas and outlets. A contract was awarded to Turriff-Burden, Ltd., of London for 314 miles of 30/32-inch pipe lines in Iraq, including 249 miles in northern Iraq between Kirkuk and the Syrian border. The other 65 miles will be laid in the Basrah area. This work is part of a project intended to raise Iraq's crude oil output capacity to about 425 million barrels annually by 1962. This amount would provide a daily production of 1,165,000 barrels. About 715,000 bpd is to be produced from the northern fields (i.e., IPC's and MPC's), and about 450,000 bpd from the Basrah fields.

Work continued last year on the loop-lines for the Kirkuk-Mediterranean 30/32-inch system. Completion was near at the year's end on a 306-mile length of new line between the Syria-Iraq border and Banias. A 38-mile loop was also being built from mile 494 in Syria paralleling the 12- and 16-inch lines terminating at Tripoli, Lebanon.

MPC. Mosul's operations remained largely status quo in 1959 and early 1960. Crude oil production last year averaged 25,666 bpd, about one percent less than the 1958 figure. Ten wells were on production at Ain Zalah field and 5 at Butmah field at the end of 1959. MPC completed an oil well and two dry holes, drilling a total of 25,468 feet of hole last year. Deep tests were finished at Anah 2 and Khleisia 1, and another test, Samarra 1, commenced in July 1959, was drilling at 8,410 feet at

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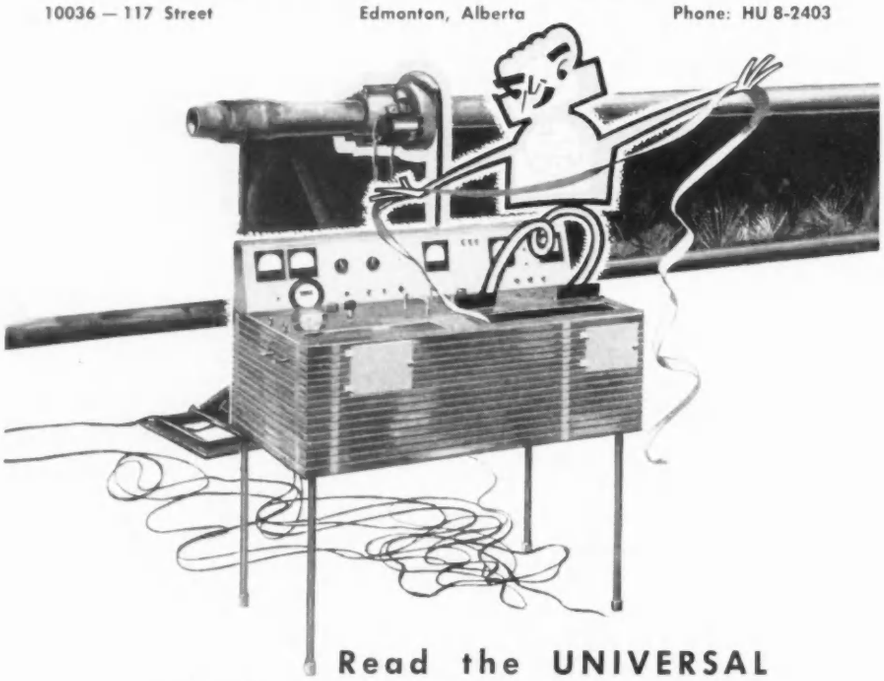

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the end of December. Anah 2 is located between IPC's T1 pump station and the Euphrates River; this test bottomed at 11,573 feet. Khleisia 1 is 55 miles north-northeast of Anah 2 and 30 miles east of the Syrian border. It was drilled to 12,438 feet (total depth) in May 1959. The Samarra test is located along the Tigris River about 70 miles northwest of Baghdad.

Production during the first four months of 1960 averaged about 26,170 bpd.

BPC. Progress continued in the Basrah area, where the Zubair and Rumaila oil fields produce from Cretaceous sandstones, as opposed to the production from carbonates in the northern fields. Crude oil output by BPC last year averaged 255,523 barrels, 11.6 percent higher than the 1958 figure (228,893 bpd).

As of the end of 1959, Rumaila field had been developed along a trend (bearing slightly northwest of north-south) 23 miles long. Width of the field average about 2½ miles. Zubair's axis is essentially parallel to Rumaila's. Zubair is 16 miles long and up to 4 miles wide.

There were 38 wells producing at Zubair and 20 at Rumaila at the end of 1959. BPC completed only 2 wells last year, a dry hole and an observation well; a total of 50,395 feet of hole was drilled. A wildcat at Samawa on the lower Euphrates River 135 miles northwest of Rumaila bottomed at 12,602 feet in March 1959. Tuba 1, located between Rumaila and Zubair fields, reached 11,939 feet by December 31. A wildcat, Kifl 1, located 30 miles south of Baghdad, commenced in August 1959, and had reached 4,746 feet at the close of the year. Rigging-up operations on two more wildcat locations were underway late in 1959, one at Dujaila, near the south bank of the Tigris River 130 miles southeast of Baghdad, and the other at Shawiya, 140 miles west of Rumaila.

BPC awarded a contract to Keir and Cawder Arrow Drilling, Ltd., for further development at Rumaila. Two rigs capable of drilling to 12,000 feet were imported, and the first two wells were commenced in December.

Crude oil production by BPC dur-

ing the first four months of 1960 amounted to about 260,00 bpd.

Expansion of facilities to boost output and to move Rumaila and Zubair crude to Fao for export continued. Three new degassing stations were to be built in Rumaila field. Turriff-Burden, Ltd., was to lay 65 miles of 30/32-inch pipe parallel to the existing 24-inch Zubair-Fao line. Two of the new stations and the new pipe line are to be completed by early 1961, and the entire project is to be finished by the end of 1961.

The Fao deep-water terminal is to be finished by February 1961. In July 1959, two huge pontoons were launched in Great Britain and towed to Iraq, and were berthed at Fao on September 30. These structures form an integral part of the deep-water terminal being built in the Persian Gulf 24 miles from Fao. The entire expansion project, including development drilling at Rumaila will cost $70 million.

Rumaila field is to have a productive capacity of about 390,000 barrels daily and Zubair, about 70,000 bpd.

Exports. Total exports in 1959 amounted to 39,169,282 tons (about 290 million barrels, or about 800,000 bpd). About 70 percent of the total moved thru IPC pipe lines to the Mediterranean, and the remainder was exported at Fao. Tankers loaded at Fao increased from 632 in 1958, to 661 in 1959, and loadings at Banias also increased from 697 in 1958, to 831 last year. Loadings at Tripoli decreased from 351 in 1958 to 333 in 1959.

Government operations. The Iraq government had not announced any specific oil policy as of mid-1960 except that it encourages exportation of as much oil as can be sold, to increase government revenues. This policy is obviously showing results.

New information on operation of Naft Khaneh field was not available in mid-1960. Only one well was reported on production there at the start of 1959. It was assumed that crude production continues there and is undergoing normal depletion.

Reportedly exploration in a portion of the old Khanaqin concession area

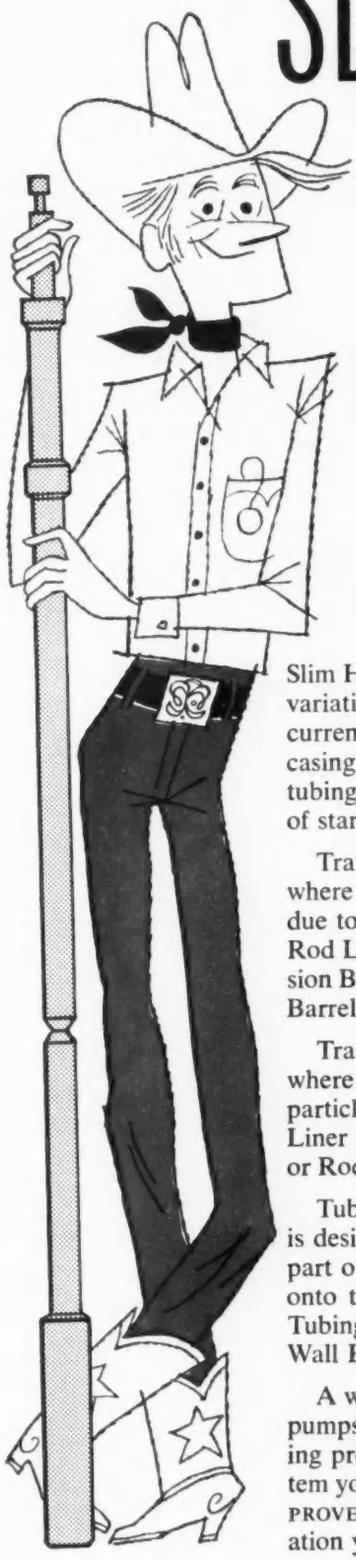

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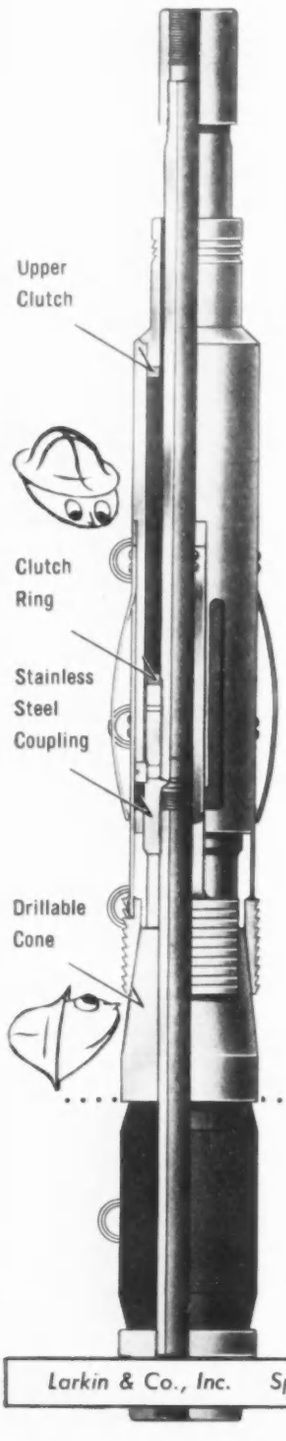
TABLE 1—Crude Oil Production, Producing Wells, and Drilling in Iraq in 1959

COMPANY	CRUDE OIL PRODUCTION Barrels 1959	Barrels 1958	Barrels Daily 1959	Barrels Daily 1958	% Diff.	Producing Wells End 1959	WELLS COMPLETED IN 1959 Oil	Other	Total	FOOTAGE DRILLED In 1959	Cumulative	Wells Drilling at End 1959
Iraq Pet. Co., Ltd	207,363,000	171,670,000	568,118	470,329	+20.8	60	10	8[1]	18	62,596	639,879	5
Basrah Pet. Co., Ltd.	93,256,000	83,516,000	255,523	228,893	+11.6	58		2[2]	2	50,395	784,123	5[3]
Mosul Pet. Co., Ltd.	9,368,000	9,112,000	25,666	25,868	— 0.8	15	1	2[4]	3	25,468	185,383	2
Khanaqin Oil Co., Ltd.[5]		1,203,000[5]		3,957[5]							n.a.	
Iraq Government	1,314,000[6]	241,000[7]	3,600[6]	3,951[7]	+415.2	1[6]						
Total, Iraq	311,311,000	266,102,000	852,907	729,047	+17.0	134	11	12	23	138,459		12

[1] Includes 1 observation, 4 water injection, and 3 wells dry and abandoned. [2] One observation well and one dry hole. [3] Includes 1 suspended well. [4] Both D and A. [5] Khanaqin operated Chia Surkh concession first 10 months of 1958; Iraq government took over in November 1958. [6] Estimated. [7] November and December production estimated. n.a. not available.



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IRAQ

is to be conducted by Russian technicians working for the Iraq government.

Some efforts by the Iraq goverment to export royalty crude have been reported. A reciprocal trade deal with Denmark reported early in 1960, would involve oil products from Iraq.

The refinery expansion at Daura (near Baghdad) being done by Foster Wheeler Corp. for the government was to be completed this year. The new thruput capacity will be 48,000 bpd. The government was also reported to be planning the revamping of the 7,500 bpd Qaiyarah refinery.

Kuwait . . .

expansion about completed

CURRENT EXPANSION PROGRAMS in Kuwait had essentially reached fruition by mid-1960. A period of routine producing, refining and export operations seems in order for the near future. Raudhatain oil field in north Kuwait commenced production in April 1960.

Following intensive development at Raudhatain during 1958 and 1959, drilling in Kuwait is being reduced this year, with 25 completions anticipated in 1960, compared to 50 recorded in 1959.

Kuwait Oil Company (KOC), operator of the concession covering the entire onshore area, completed a wildcat oil discovery at Minagish in 1959.

Crude oil production. Crude output declined slightly last year, temporarily reversing a trend of steady and often abrupt annual increases evident in the post-World War II years. The 1959 yield amounted to 504,855,244 barrels, an average of 1,383,165 bpd, 12,404 daily or 0.9 percent less than 1,395,569 bpd of 1958. Last year's production was from 319 wells reported flowing as of December 31 in Burgan-Magwa-Ahmadi fields. An additional 38 oil wells in north Kuwait were shut in at the close of 1959, awaiting production facilities.

Completion of an 80-mile, 30-inch crude oil pipe line from Raudhatain field to the Ahmadi tank farms and commencement of production at Raudhatain in April 1960, was ex-

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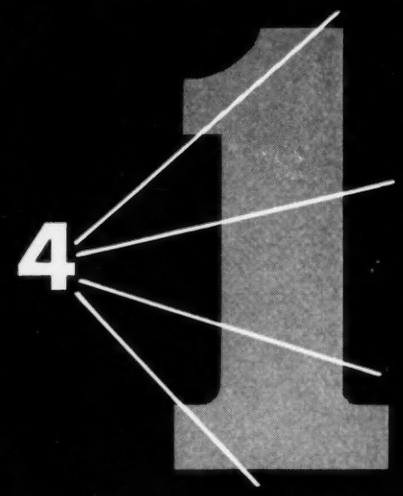

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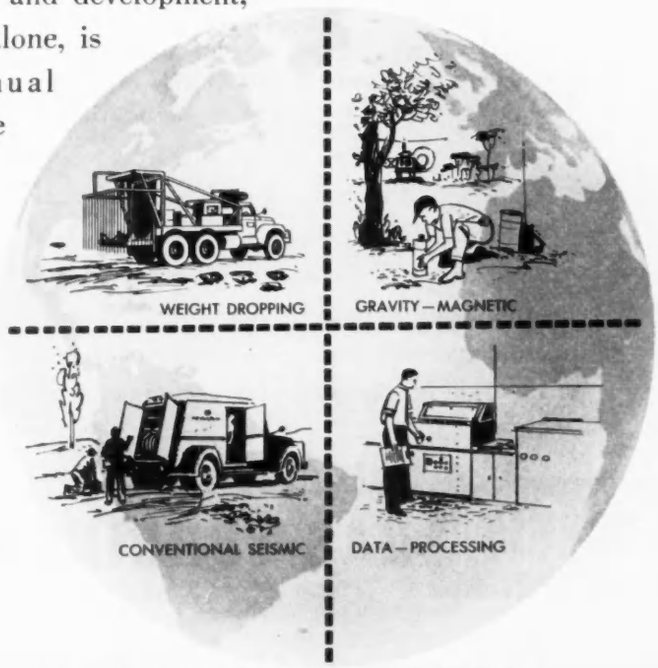

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KUWAIT

pected to increase crude oil production during the rest of 1960 from 100,000 to 200,000 barrels daily.

A pilot plant for dehydrating and desalting up to 10,000 barrels daily of wet crude was being built in the older fields last year.

Drilling. Development drilling in north Kuwait was stressed last year, and about 30 wells were also completed in the older fields. The 48 field completions consisted of 47 oil wells and one gas injection well, aggregating 202,000 feet of hole.

Exploratory drilling amounted to 20,254 feet. One wildcat (Minagish 1) was completed for oil. Another exploratory hole, Dibdibba 1, located 45 miles west of Magwa field, was dry at 9,438 feet (total depth). Mutriba 1, a test abandoned in 1958, was re-entered and deepened from 10,700 to 11,516 feet. The well was suspended at the close of 1959, owing to a fishing job.

Two rigs were active at the end of 1959, including one on a confirmation test, Minagish 2. There were 13 completions in Kuwait during the first half of 1960.

Minagish discovery. Minagish 1, spudded in 1959, is located about 22 miles west of Burgan field and 8 miles

Oil Operations in Kuwait in 1959
(All by Kuwait Oil Company Limited)
Crude Oil Production (Barrels)

Total 1959	Daily 1959	Daily 1958	Percent Decrease
504,855,244	1,383,165	1,395,569	0.9

Crude Oil Producing Wells at End of 1959

Flowing	Pumping	Unconnected	Total
319		38*	357

Field Wells Drilled During 1959

Oil	Gas Injection	Dry	Total
47	1	0	48

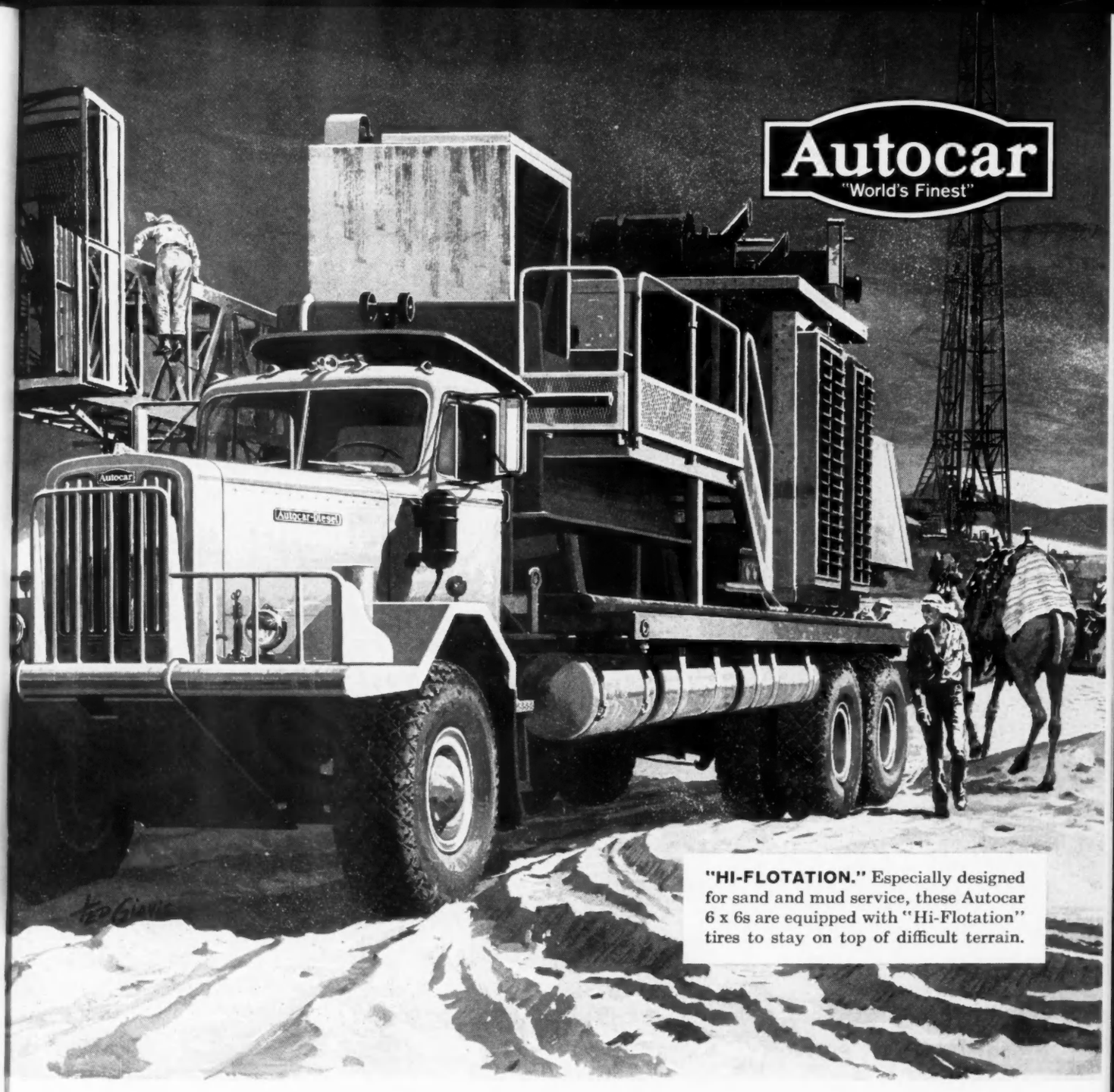
Footage Drilled During 1959

Development	Exploration	Total
202,000	20,254	222,254

Wells Drilling

Number of wells drilling as of 12-31-59..... 2

*Includes 27 completed oil wells in northeast Kuwait awaiting production facilities.



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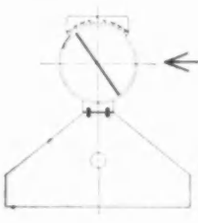

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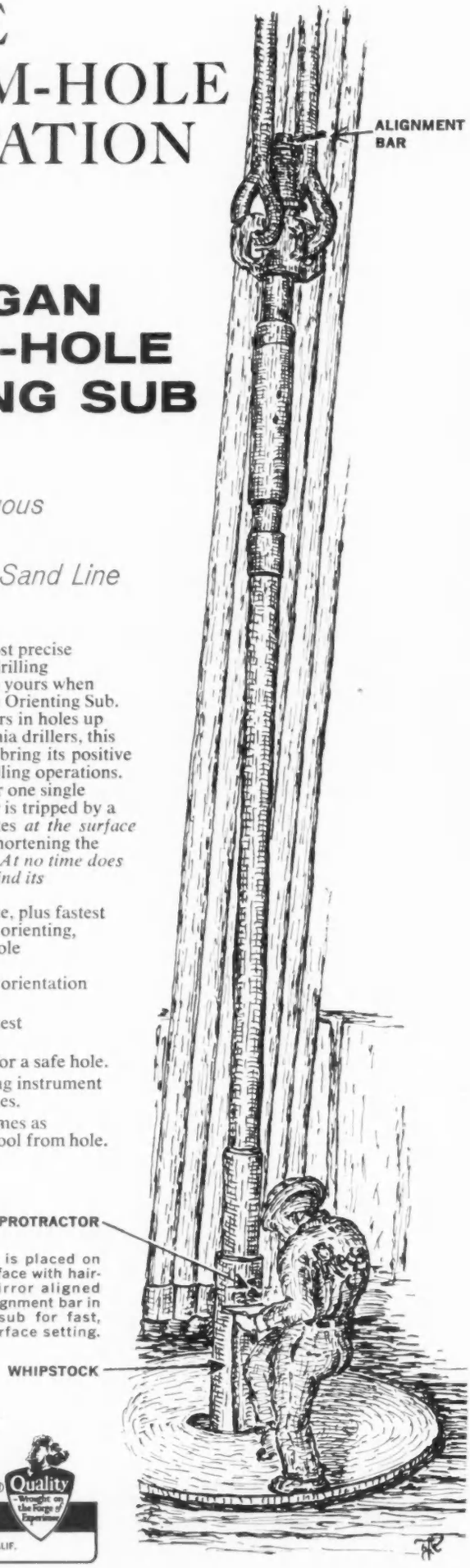

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KUWAIT

north of the Neutral Zone border. Discovery was made in May 1959, when the Ratawi limestone was found just above 10,000 feet. The well flowed 1,660 barrels of 34.5° API gravity crude with a sulfur content of about 2 percent. Minagish 2 is located 1¼ miles southwest of 1. Producing facilities were being planned.

Conservation. A gas injection project was to enter operation at Burgan field in mid-1960. Two compressors, each driven by a 7,000-hp gas combustion turbine, will compress 100 MMcf of natural gas daily from about 400 to 1,900 psi pressure in two stages for injection into the oil reservoir.

Storage and shipping facilities. Crude oil storage at Ahmadi was increased in 1959. By December 31, there were 34 tanks at the south tank farm comprising a capacity of 5,460,000 barrels. The north tank farm had 12 tanks aggregating 2,894,000 barrels capacity. Three 38/40-inch gravity lines connecting storage installations on Ahmadi Ridge with the new north pier at Mina al Ahmadi were commissioned in 1959.

Completion of the north pier in June 1959 was a major development. Now, 11 tankers may be loaded simultaneously at Mina al Ahmadi, 8 at the south pier, and three at the north pier. Including 7 usable sea-loading berths, Mina al Ahmadi has an export capacity of 2,145,000 barrels daily and is the largest oil exporting port in the world. A total of 2,488 tankers took on cargos there last year. The first 100,000-ton tanker to take on Kuwait oil was loaded in March 1959.

Refining. KOC's Mina al Ahmadi refinery charged a daily average of 142,500 barrels of crude daily in 1959, compared to 119,800 bpd in 1958. Crude charging capacity is 190,000 bpd.

A new Platformer was commissioned in June 1959, to produce 4,000 barrels of high-grade motor gasoline daily. The bitumen plant was being expanded to fulfill needs of increased local road-building activity, and an LPG plant also was built.

New offshore concessions? Early in 1960, the ruler of Kuwait invited bids on Kuwait's territorial waters

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beyond the limit of KOC's concession, which extends six miles beyond low-water mark from Kuwait's coast and islands. The Shaikh indicated that he wished to conclude the matter by this November. However, the delineation of offshore territorial limits, particularly at the head of the Persian Gulf, is still an unsolved international problem (see Editorial, page 9).

Neutral Zone . . . drilling on the increase

EXPLORATORY and development drilling appeared to be reaching a new high in the Neutral Zone in 1960. Arabian Oil Co., Ltd, the Japanese firm, is rapidly developing its important discovery on the offshore concession, 35 miles east and slightly south of the firm's temporary base camp at Khor-Al-Muffata, and about 45 miles north of Safaniya field in Saudi Arabia. (See Map on page 212).

Onshore, American Independent Oil Co. and Getty Oil Co. continued to expand crude oil production from Wafra field. Getty announced a new geophysical program for 1960 and intention to drill any indicated wildcat prospects.

Offshore work. In mid-1960, Arabian Oil Co. was drilling Khafji 3, having completed two prolific oil producers. Khafji 1 was spudded on July 19, 1959. On August 3, a gas blowout occurred at 1,507 feet. The sour gas caught fire and the derrick fell into the sea the next day. However, the fire was extinguished, the damage was repaired, and Khafji 1 was re-entered in time to be completed before the end of 1959. The discovery was completed at 5,450 feet in the Burgan zone, capable of flowing about 6,000 barrels of oil daily.

Khafji 2 was located about 2½ miles west and slightly south of the discovery, and was brought in early in 1960 as a well similar to the first. The Khafji 3 location is about a mile east of 1.

In 1960, Arabian Oil intends to complete 8 wells, using two offshore drilling outfits, one each under contract to International Drilling Co., N V and Seacat Offshore Drilling Co. A rig began work under the latter contract this year.

McDermott International, Inc., was awarded a contract by Arabian Oil on March 31 to build initial temporary oil producing and shipping facilities. Construction was to begin in September and to be completed by the end of 1960. Arabian Oil expected to start shipping oil early in 1961, if not sooner. AOC will use five T-2 tankers for offshore storage. A submarine pipe line to the shore base may be laid in about a year. Pomeroy-Hawaiian Dredging Co. was at work in mid-1960 at AOC's permanent base camp at Ras-Al-Khafji, 20 miles south of Khor-Al-Muffata. A pier and tank farm will be built at the new base.

Rapid expansion of crude output is expected in the future, since, like Safaniya crude, the oil found at Khafji field is of relatively high quality, containing a high aromatics content, well suited to the booming

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Japanese petrochemical industry. Some of its characteristics follow: API gravity, 26.6°; viscosity, 146 sec at 30° C; sulfur content, 2.7 percent. This crude has a 52.5 percent residual yield on fractional distillation, 21.5 percent gasoline, 17.5 percent gas oil, and 8.5 percent kerosine.

This oil appears to be very similar to Safaniya crude, despite the considerable distance from Safaniya field and the fact that Arabian Oil spotted their first location about 15 miles north of the Neutral Zone-Saudi Arabian border. AOC intends to be producing about 175,000 barrels daily by 1965.

Onshore developments. Aminoil and Getty continued vigorous work to increase crude oil output. Crude oil production from Wafra field amounted to 42,438,490 barrels in 1959, an average of 116,270 daily, representing an abrupt 44.8 percent increase from the 80,301 bpd of 1958 (Table 1). Production is expected to be similarly increased in 1960 to about 55 million barrels (151,000 daily). April 1960 production was 125,000 bpd.

Active field development drilling continued, with 40 oil wells completed in 1959. Total footage onshore was 104,267 feet, compared with 102,424 in 1958. As of December 31, 1959, an

TABLE 1—Oil Operations in the Neutral Zone in 1959

By American Independent Oil Co. and Getty Oil Co. (Onshore Operations)

Crude Oil Production

Year	Barrels	Barrels Daily	% Gain Over Year Before
1959	42,438,490	116,270	44.8
1958	29,310,000	80,301	26.3

Crude Oil Producing Wells at End of 1959

Flowing	Pumping	Shut In	Total
178	.....	19	197

Field Wells Completed in 1959, by Zones

Zone	Oil	Gas	Dry	Total
Eocene	31[1]	.....	.....	31
Ratawi	6	.....	.....	6
Unidentified zone; shut in	3	.....	.....	3
Total	40	.....	.....	40

[1]Includes 13 First Eocene, 17 Second Eocene, and 1 Third Eocene zone wells.

Footage; Wildcatting; Drilling

Footage drilled in 1959	104,267
Wildcats drilled in 1959	None
Wells drilling December 31, 1959	3

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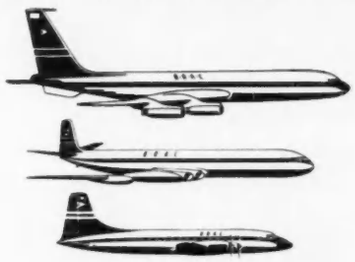

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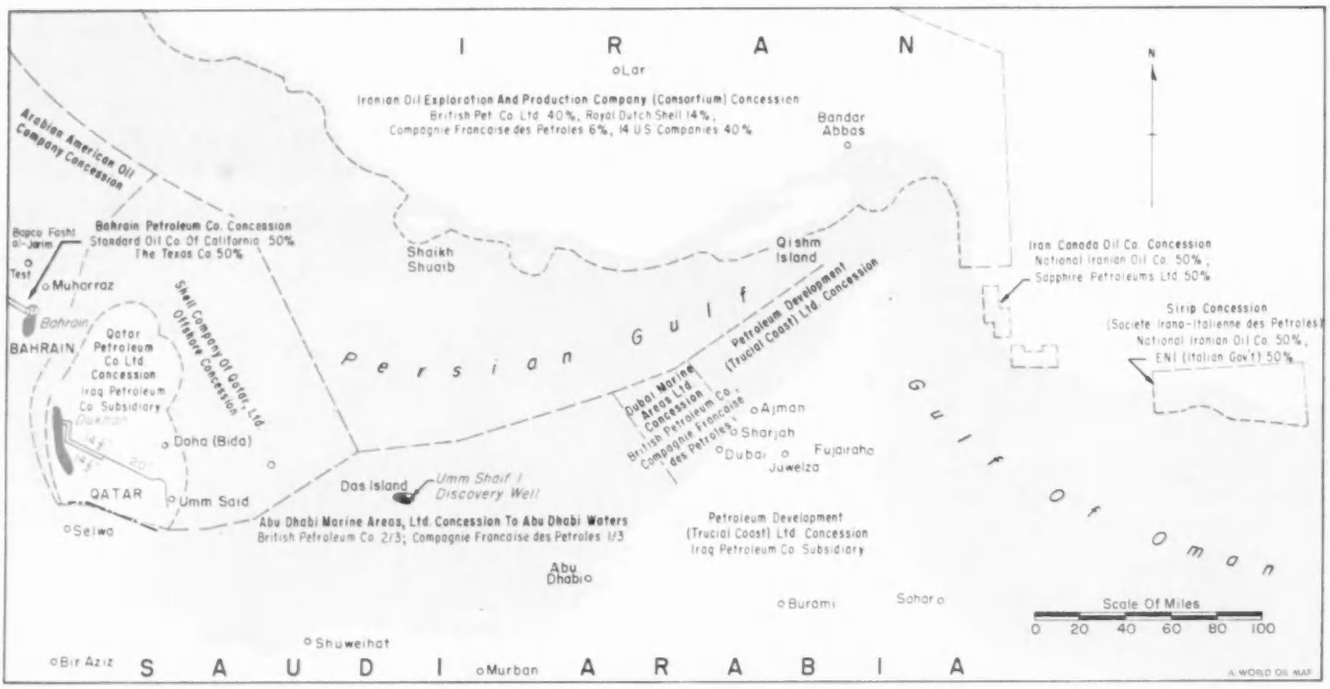

Abu Dhabi's oil resources were being developed rapidly, as activity quickened in the southern Persian Gulf area. Umm Shaif field was extended westward during 1959 and 1960, and a new pay in the Jurassic was found at about 9,600 feet in the Areji limestone, confirming commercial production. A submarine pipe line to Das Island and a gathering system in the field were to be built. Onshore on the Murban structure, interesting oil shows were reported below 8,400 feet in April 1960. Shell Company of Qatar was drilling a deep test about 55 miles east of the Qatar Peninsula in 1960, and Bahrain Petroleum Co. (BAPCO) announced an offshore wildcat, Fasht al-Jarim 1, to be drilled late in 1960 about 15 miles north of Manama. In south Iran, Suru 1 was being drilled in 1960 near Bandar Abbas. Geological and gravity coverage of south Iran continued.

additional 13 First Eocene wells, 17 Second Eocene, 1 Third Eocene well, and 6 Ratawi wells had been completed and connected with the main gathering station. Completion of these wells boosted the extent of the proven Ratawi zone by about 500,000 acre feet, of the Second Eocene by 143,000 acre feet, and established production in the Maestrichtian zone. Current development drilling is intended primarily to establish the southern productive limits of the Wafra and Fuwaris structures.

At the end of the year, Wafra field comprised 20 Ratawi, 46 Burgan and 131 Eocene wells completed and either producing or capable of production. These 197 wells can produce about 148,000 barrels of crude daily.

A plant to provide desalting by ion segregation entered operation at Wafra last year. Getty moved in two new rigs in 1959, one for deep development drilling, the other for workovers.

Expansion of storage and pipe line facilities continued. Field storage capacity was increased by 60,000 barrels in 1959 and 32 miles of gathering lines were laid. A new 100,000 barrels daily pumping station was added to boost oil movement to Getty's Mina Saud marine terminal. Combined storage capacity at Mina Saud was 1,760,000 barrels at the end of 1959.

Qatar . . . crude oil production off 2.7 percent

Qatar Petroleum Co. Ltd. (QPC), continued to produce Dukhan field, the peninsula's only known oil deposit, at its approximate optimum rate in 1959 and 1960. Crude oil production in 1959 amounted to 62,197,000 barrels, an average of 170,403 bpd. This was 4,693 bpd or 2.7 percent less than the 1958 rate of 175,096 bpd. Fifty wells were producing at the end of 1959, the same as a year earlier. Production during the first quarter of 1960 averaged about 185,000 bpd.

QPC drilled only one well, a deep test, Dukhan 65 at 13,261 feet in December. It was completed as an observation well. Total footage drilled last year was 8,516. Dukhan 66 was being rigged up at the start of 1960.

Some exploratory activity took place on the mainland, with seven party-months of reflection seismograph work being done by QPC.

Tanker loadings at Umm Said declined in number from 383 in 1958, to 317 in 1959. Oil exports in 1959 amounted to 7,857,631 tons (62,125,574 barrels, or 170,207 bpd).

Shell Company of Qatar, Ltd. commissioned its new mobile offshore drilling platform "Seashell" last December at Doha Bay, after the new outfit had been towed 6,400 miles from Holland. The new $5 million platform, built to replace a previous one wrecked in December 1956, is designed to drill in water depth of 100 feet. Early in 1960, the platform was towed to a location 55 miles off the east coast of Qatar at 25° 30′ north latitude, 52° 24′ east longitude. On April 15 the well reached a depth of 8,000 feet. There were reports in mid-1960 of gas in the Arab zone (Jurassic) and deeper oil shows, but such findings were not confirmed by the operators at the time.

WINNING COMBINATIONS

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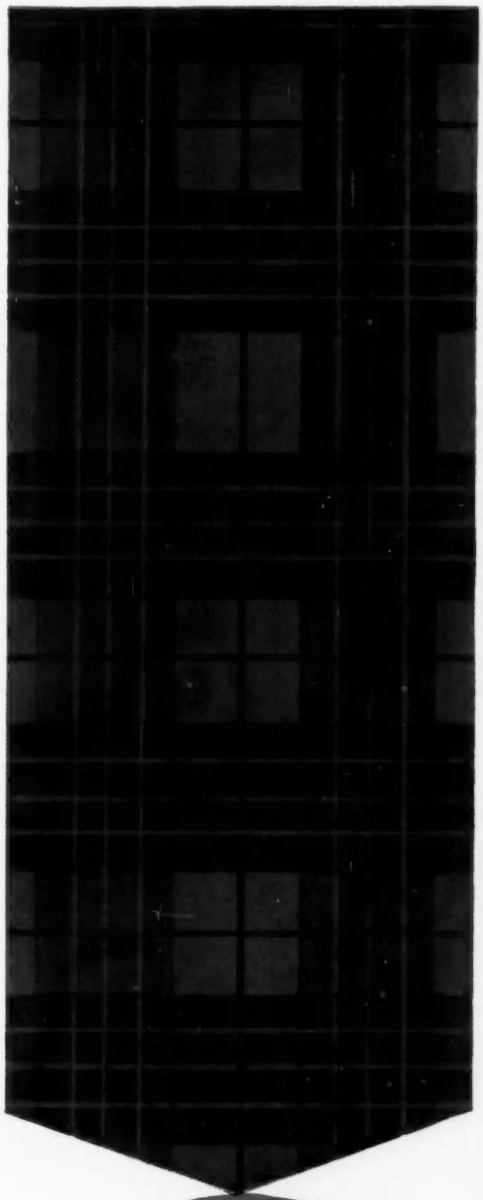

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Saudi Arabia . . . progress is orderly

ORDERLY, well-planned progress marked Saudi Arabia's oil industry in 1959 and 1960. Khurais field, the country's farthest inland crude deposit, was essentially delineated. Development continued at Manifa, the nation's second offshore oil field. Conservation programs were in high gear as two of the older oil fields showed decreased output.

Crude oil yield continued to rise. Refinery runs increased also in 1959, reversing a decline of several years in the Ras Tanura plant's thruput. Perhaps the most newsworthy event is Arabian American Oil Company's vigorous campaign to stimulate use of natural gas in Saudi Arabia and to export it if possible.

Production. Crude oil production in Saudi Arabia amounted to 399,820,590 barrels in 1959, an average of 1,095,399 barrels per day (Table 1). This was 7.9 percent more than the 1,015,029 bpd in 1958. A record for production in a single day was set March 27, 1959, when 1,351,484 barrels flowed from Aramco's wells. Production last November averaged 1,210,299 bpd, highest for any month up to then. However, a new record of 1,210,564 bpd was set in April 1960.

The mammoth Ghawar field continued to lead other Saudi Arabian fields in crude output, producing 701,846 bpd in 1959, 64 percent of the country's total. Ghawar's 1959 yield was 3.5 percent above the 1958 output of 678,100 bpd. Abqaiq field also showed an increase (9.8 percent) last year, producing 267,316 bpd compared to 243,373 in 1958. Pressure maintenance programs at Abqaiq are working quite well. The most striking increase by field in 1959 was at Safaniya, where production was about doubled to 76,177 bpd, against 38,048 in 1958. Last year was Safaniya's second full year on production. Dammam and Qatif fields showed slightly decreased output in 1959.

Saudi Arabia's 1959 crude yield was from 201 flowing oil wells as listed in Table 1, including 91 in Ghawar, 56 in Abqaiq, 21 in Safaniya, 25 in Dammam and 8 in Qatif. The average output per producing well last year was 5,450 barrels daily.

Crude production in the first four months of 1960 set an all-time high for this period, averaging 1,212,702 bpd, compared to 1,076,575 in January-April 1959.

Pressure maintenance facilities dot map of Saudi Arabia as LPG injection enters Aramco's conservation program to augment gas and water injection.

At Khursaniyah field, construction of gathering and separating facilities started last year. This field, discovered in 1956, was to enter production in 1960 with an initial output of 45,000 barrels daily. Construction of a gas-oil separator plant (GOSP) at Khursaniyah, located 105 miles northwest of Dharan near the midpoint of the Safaniya-Ras Tanura 22-inch crude oil pipe line, began in August 1959, and was completed early this year. The plant has facilities for 10 flow lines. It was to be connected with five wells initially. The flow lines are 8-inch; and there is a 3-mile, 24-inch tie line connecting to the main pipe line. Khursaniyah crude, which is lighter and sourer than that from Safaniya, will apparently be batched in the line. A pumping station was completed in 1958 at Khursaniyah to move up to 190,000 barrels daily of either type of crude.

Pressure maintenance. The largest gas injection plant in the Middle East began operation at the 'Ain Dar structure of Ghawar field in February 1959. At the year's end it was injecting gas under 2,100 psi pressure at rates exceeding 160 MMcf daily.

A miscible phase injection program was being begun in the north dome of 'Ain Dar. About 37,000 barrels daily of raw LPG will be pumped from Abqaiq to 'Ain Dar, where it will be mixed with a high-pressure (2,100 psi) gas stream from the 'Ain Dar gas injection plant. This new $8 million program is to be completed in June 1961.

At Abqaiq, expansion of gathering and separating facilities in the northern part of the field was to be finished in 1960. The northern part of the

TABLE 1—Crude Oil Production and Wells in Saudi Arabia in 1959, by Fields and Zones

Field and Zone	PRODUCTION IN 1959		WELLS AT END OF 1959							
	Total Barrels	Barrels Daily	Producing	Shut in or Standing	Observation	Injection	Suspended	Abandoned	Drilling	Total
Ghawar										
'Ain Dar			44	6	3	6[3]	1	1	..	61
Shedgum			14	1	1	..	..	1	..	17
'Uthmaniyah			33	10	3	..	1	2	..	49
Hawiyah			..	1	1	..	..	0	..	2
Haradh			..	7	1	..	1	0	..	9
Fazran			..	3	2	..	..	2	..	7
Total Ghawar	256,173,790	701,846	91	28	11	6	3	6	..	145
Abqaiq	97,570,340	267,316	56	6	4	12[1]	..	2	..	80
Safaniya	27,804,605	76,177	21	11	1	..	..	..	..	33
Dammam	12,430,440	34,056	27[2]	4[2]	1	..	..	10[2]	..	42
Qatif	5,841,415	16,004	8	2	1	..	1	1	..	13
Abu Hadriyah			..	1	1	..	..	2	1	5
Fadhili			..	1	..	..	..	..	..	1
Khurais			..	9	1	..	..	2	1	13
Khursaniyah			..	5	2	..	..	1	..	8
Manifa			..	5	..	..	..	..	1	6
Four other areas[4]			..	..	..	..	..	4	..	4
Total	399,820,590	1,095,399	203[2]	72	22	18	4	28	3	350

[1] Includes 3 gas injection and 9 water injection wells. [2] Includes 2 gas wells. [3] All are gas injection wells. [4] Dry holes at al-Alat, Jauf, Ma'aqala, and stratigraphic well.

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field is away from the gas cap existing in the more pronounced and higher structural closure in the southern portion.

Also at Abqaiq, construction was to begin this year on a $7.4 million plant to process 55 million feet of heavier, low-pressure gases daily. Heretofore these gases have been flared. Completion of the plant is slated for 1961. When it enters operation, Aramco will be using about 73 percent of all casing-head gas produced, either for reservoir pressure maintenance, for fuel, or for other industrial purposes.

Water injection in the northern segment of Abqaiq increased from about 240,000 barrels in 1958 to about 300,000 barrels in 1959. Tests are continuing to determine the worth of the project to inject sea water into the Abqaiq field reservoir (WORLD OIL, August 15, 1959, page 204.) Generally, Aramco's pressure maintenance programs are proving more effective than originally visualized.

TABLE 2—Crude Oil Run from Field Storage in Saudi Arabia in 1959

Destination	Total Barrels	Barrels Daily	% of Total
To tankers at Ras Tanura	160,395,769	439,440	40.2
To tapline facilities at Qaisumah	124,139,355	340,105	31.1
To Ras Tanura refinery tankage	63,609,799	174,273	16.0
To Bahrain via pipe line	50,785,944	139,140	12.7
Total	398,930,867	1,092,961	100.0

In the southern portion of Abqaiq, the Arab zone (Jurassic) D member is a carbonate section 200 feet thick with average porosity of 22 percent and average permeability of 500 md. Depth is about 6,500 feet. The rock is primarily a pellet-type calcarenite, with some oolites and dolomitization being present. There are no continuous bedding planes. The highly successful pressure maintenance programs at Abqaiq are being carefully watched, since their applicability to other prolific Middle East carbonate reservoirs (e.g., Kirkuk in Iraq) will have an enormous influence on probable future recoverable reserves.

Crude oil movement. As shown in Table 2, an average of 1,092,961 bpd was run from field storage in Saudi Arabia last year. Deliveries to tankers at Ras Tanura increased to 40.2 percent of the total. Deliveries to the Trans-Arabian pipe line (Tapline) decreased slightly to 31.1 percent. Movement of crude to Ras Tanura refinery tankage and to Bahrain was only slightly above comparable figures in 1958.

Drilling. Twenty-two deep wells were completed by Aramco last year, and 141,490 feet of hole was cut. Both figures were slightly reduced from the 23 completions and 159,347 feet drilled in 1958. Included in the 1959 completions were 11 oil wells, 2 injection wells, 5 dry holes and 4 observation wells. No wildcats were completed last year. Aramco stated that 1959 drilling disclosed 2 billion barrels of crude oil reserves beyond the amount withdrawn last year. The official Aramco reserves estimate was 38.6 billion barrels at the end of 1959.

Two gas injection wells were completed last year in south 'Ain Dar. One oil well, two observation wells

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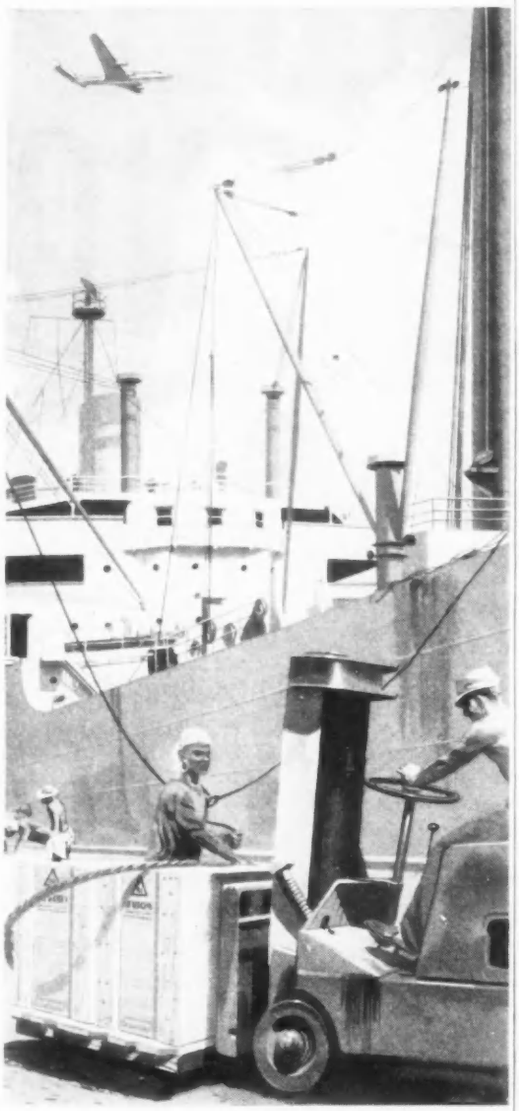

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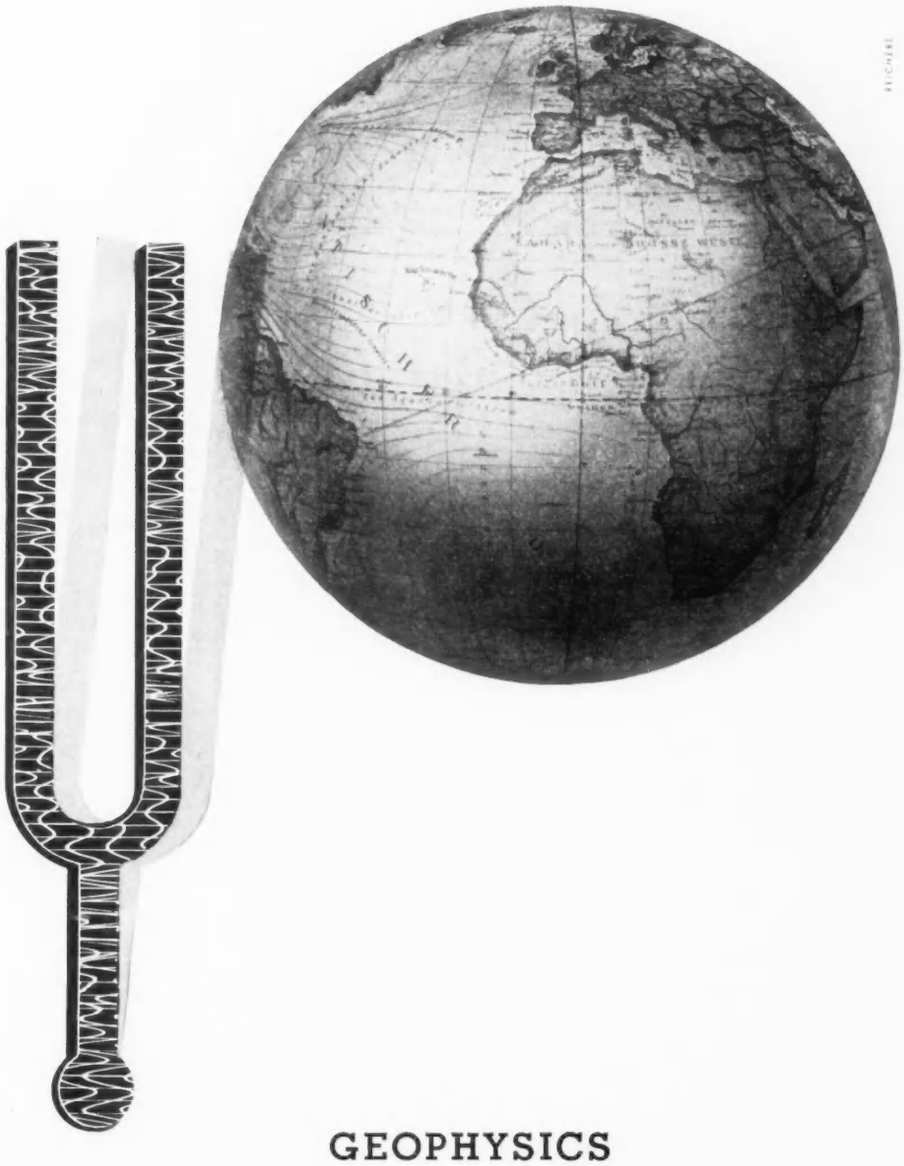

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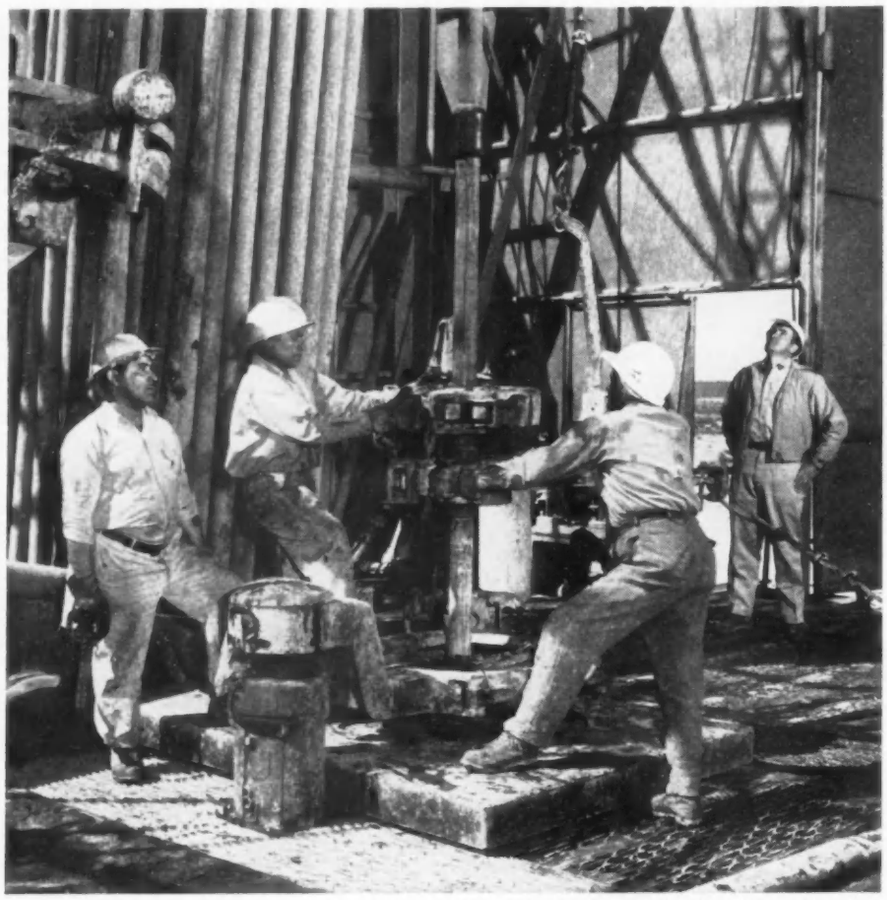


Photo courtesy Arabian American Oil Company

Saudi Arab members of a drilling crew of the Arabian American Oil Company. By the end of 1959, Saudi Arabs constituted 71.9 percent of Aramco's 16,257 employes in Saudi Arabia, and 76 percent of the Saudi Arabs held semi-skilled, skilled and supervisory or professional jobs.

and two dry holes were completed at Fazran. Maps released by Aramco do not make clear whether Fazran has been definitely proven to be continuous with the 'Ain Dar portion of Ghawar field. But the company lists Fazran as part of Ghawar for statistical purposes. The Fazran productive area is more than 12 miles long and 2 miles wide. Northeast limits were not known.

At Khurais field, 6 development wells and 1 observation well were finished in 1959, and another development well was being drilled at the end of December. Khurais 4 bottomed at 13,560 feet after exhaustive tests of the Khuff (Permian) formation proved negative. This well is now completed in the shallower Arab D member. The Khuff limestone was the original target of the Khurais discovery well. Despite the unsuccessful experience with the Khuff at Khurais, Aramco apparently is very interested in Khuff oil possibilities. Gas is produced from the Khuff farther down dip (at Dammam).

Two unsuccessful extensions were also finished at Khurais last year. Fourteen tests have been drilled so far. Khurais field as so far defined is 31 miles long and 8 miles wide.

At Khursaniyah field, two development wells and one unsuccessful step-out were completed in 1959. The producers showed unquestionably that the field merits being put on production. Khursaniyah is 7 miles long and 4½ mile wide.

In the Manifa offshore field, three wells were completed last year and Manifa 6 was being drilled at the end of 1959. The field limits are still unknown. But the Manifa zone oil deposit is definitely 14 miles or more in length.

Exploratory drilling was resumed in Abu Hadriya field in July 1959, and Abu Hadriya 5 was being drilled at year's end. As of early May 1960, Aramco was drilling Manifa 7, Abu Hadriya 5 and was doing further development work at 'Ain Dar.

Other exploration. One seismic crew worked in the northern region in early 1959 between the Dibdiba Gravel Plains and the eastern edge of the Dahna region. At mid-year 1959, this group moved southeast for additional work in the El Haba region.

Most of the year's basic exploratory effort was concentrated in the western and southern portions of the Rub'al-Khali (the "Empty Quarter"). Two seismic crews and 4 structure drill crews were active during the first half of 1959. Three structure-drill parties worked in the western section, mapping regional structure on shallow horizons. The other drilled rotary holes in the southern Rub'al-Khali, some as deep as 6,000 feet.

One seismic crew worked the southwestern Rub'al-Khali to augment structure drill work done in 1958. The other crew did reconnaissance work in the sand mountain area of the eastern Rub'al-Khali. Some refraction work was being done as of May 1960. A total of 31 party-months of seismic work was done in Saudi Arabia in 1959, according to a report to be published in *Geophysics*, Volume 25, No. 6.

The United States Geological Survey and Aramco are continuing their mapping program of the Arabian Peninsula. This plan is jointly sponsored by the Kingdom of Saudi Arabia and the U. S. State Department.

Gas sale promotion. Aramco is making a strong effort to promote greater utilization of natural gas in Saudi Arabia and to develop export markets for surplus gas if possible. Aramco expects to produce 750 MMcf daily in 1962, to use 550 MMcf daily in its own operations and hence to have a surplus of about 200 MMcf. Current Middle East gas production, almost all of it casinghead gas produced with oil, is about 2,830 MMcf daily.

Aramco estimates its surplus gas as follows: 'Uthmaniyah, 107 MMcf daily; Abqaiq, 28 MMcf; 'Ain Dar, 27 MMcf; Shedgum, 11 MMcf; Qatif, 10 MMcf, and Safaniya and Khursaniyah, 9.5 MMcf daily each. A plant being built near Hofuf by a Saudi Arabian firm will consume about 2 MMcf daily. A 7-mile, 8-inch pipe line was to be built from Aramco's Shedgum GOSP to this plant. Aramco is also trying to encourage

use of gas in electrical power generation, fertilizer and lime plants.

Exportation of gas as liquefied methane is also being considered. If such trade becomes a commercial reality, raw, sour Saudi Arabian natural gas is expected to sell at from 5 to 6 cents an Mcf. This gives an idea of some competitive pricing conditions that may occur in the future if international methane shipments become commonplace.

In addition, Aramco is building a plant at the Ras Tanura refinery which will make available for export 4,000 barrels of LPG daily early in 1961.

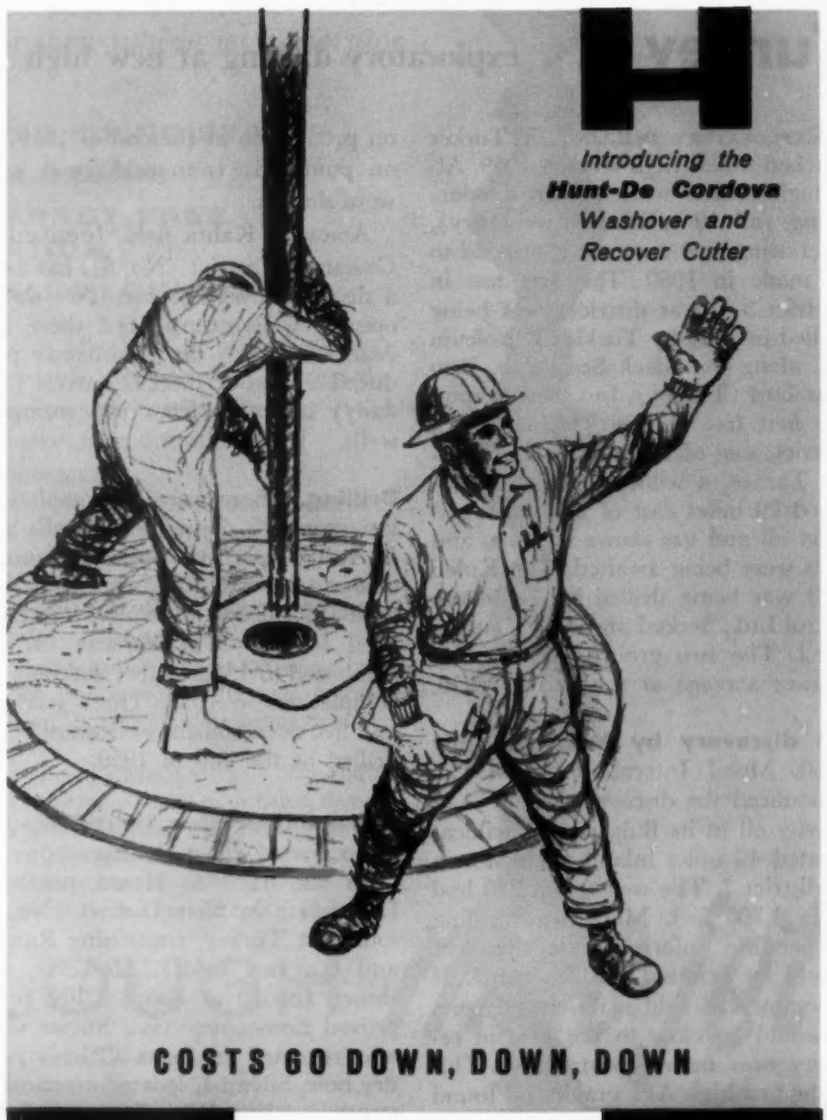
Aramco is hampered in its efforts to attract local industry by the limited nearby markets for industrial products. But the company's strong efforts to develop ground water reserves concurrent with oil exploration will be helpful in this endeavor.

Pipe lines. Construction began in 1960 on a 73-mile, 30-inch crude oil pipe line to loop part of the Safaniya-Ras Tanura line. The new $11 million project, which includes added pumping facilities, will allow delivery of 215,000 barrels daily of crude from Safaniya and 75,000 barrels a day from Khursaniyah. South of Khursaniyah, the 22-inch line will be used exclusively to move Khursaniyah crude to Ras Tanura. Completion of the entire project is scheduled for October 1960.

Refining. Crude oil thruput at the Ras Tanura refinery last year was 174,273 barrels daily, an increase of 3.7 percent over the 168,119 bpd in 1958. Crude processing continued to increase in 1960. An average of 214,516 barrels per calendar day was charged at Ras Tanura during the first four months of this year, compared with 176,817 bpd in the same period in 1959.

In addition to the aforementioned LPG plant which came under construction, an alkylation plant was added in June 1959. Ras Tanura now produces both conventional aviation gasoline and jet fuel.

New pier. The Ras Tanura marine terminal now has 10 tanker berths, after installation of an 800-foot extension to the north pier in July 1959. A total of 1,502 tankers, an average of 125 monthly, loaded petroleum cargoes at Ras Tanura last year.



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Turkey . . . exploratory drilling at new high

EXPLORATORY DRILLING in Turkey reached a new high level in 1959. Although results were rather discouraging (all 19 wildcats were dry), interesting new ventures continued to be made in 1960. The first test in District 3 (Sivas district) was being drilled in May by Turkish Petroleum Co. along the Black Sea shore. Esso Standard (Turkey), Inc., was to spud the first test in District 2 (Ankara district, east of 3) in May. In Turkish Thrace, a wildcat (Kuleli 1) located 20 miles east of Edirne, found good oil and gas shows in June, and tests were being awaited. The Kuleli well was being drilled by Deilmann Petrol Ltd., Serketi and N. V. Turkse Shell. The two groups pooled their Thrace acreage at the end of 1959.

Oil discovery by Mobil. In July 1960, Mobil International Oil Co. announced the discovery of 36° API gravity oil in its Bulgardag 1 wildcat located 40 miles inland from Mersin in district 7. The well tested 240 bpd from 4,700 feet. Mobil was drilling deeper but inferred that the well would be acidized and fractured. If a commercial field is developed here, it would be close to the Mersin refinery now under construction. This is the first high API gravity oil found in Turkey, and the find could cause many companies, recently discouraged by dry holes, to renew their exploratory efforts.

Production. Crude oil production increased in 1959 to 2,655,219 barrels, or 7,275 barrels daily (Table 1). This was a 13.2 percent increase over the 6,215 bpd of 1958. The increase was due almost entirely to further development of Garzan and Raman fields, operated by Turkiye Petrolleri Anonim Ortakligi (Turkish Petroleum Co.). Turkish Petroleum had 44 wells on production at the end of 1959, all on pump. Sixteen additional wells were shut in.

Amoseas' Kahta field, located in Gaziantep District (No. 6), has been a disappointment so far. Two development wells completed there last year were both dry. Amoseas produced a total of 108,292 barrels (297 daily) last year from two pumping wells.

Drilling. There were 34 completions last year—15 development wells and 19 wildcats. Development footage amounted to 69,700 feet. Together with 127,782 feet of exploratory hole, total footage in 1959 was 197,482 compared to 158,545 feet and only 22 completions in 1958. Three wildcats and five development wells were being drilled at the end of 1959.

Other exploration. Bolsa Chica Oil Corp. found some shallow shows in 1958 and 1959 at Hazro, north of Diyarbakir in Siirt District (No. 5, southeast Turkey, containing Raman and Garzan fields). However, the shows, found at about 1,100 feet, proved non-commercial. Shows were also reported in Bolsa Chica's next dry hole, Silvan 1, located on another structure about 12 miles east of the Hazro prospect. Silvan 1 was abandoned in November 1959 at total depth of 6,138 feet. Additional drilling on the Silvan structure was tentatively planned.

Geophysical activity declined last year. Seismograph crew-months amounted to 80.5 in 1959, down from 116 of 1958. Gravity work decreased to 15 crew-months last year from 28 in 1958, and magnetic party-months dropped to 5 last year from 16.5 in 1958. Such work is expected to decline further this year.

TABLE 1—Production and Development Drilling in Turkey in 1959

COMPANY	Crude Oil Production		Crude Oil Producing Wells at End of Year				Field Wells Completed					Wells Drilling at Year End
							Wells					
	Total Barrels	Bbls. Daily	Flowing	Pumping	Total	Shut in	Oil	Gas	Dry	Total	Footage	
*Turk. Pet.	2,546,927	6,978	....	44	44	16	13	0	0	13	65,600	5
†AOP Ltd.	108,292	297	....	2	2	1	0	0	2	2	4,100	0
Total	2,655,219	7,275	....	46	46	17	13	0	2	15	69,700	5

*Turkiye Petrolleri AO. †American Overseas Petroleum, Ltd.

TABLE 2—Exploratory Wells Drilled in Turkey in 1959
(All Wells Completed were Dry and Abandoned.)

Company and Well	Total Depth (Ft.)
COMPLETED IN 1959	
American Overseas Petroleum Ltd., Sahabe 1	4,709
Bolsa Chica Oil Corp., Hazro 1	4,050[1]
Hazro 2	1,168[1]
Hazro 2-A	6,045[2]
Silvan 1	6,138
Esso Standard (Turkey), Inc., Kastel 1	10,445
Kavika Dag 1	9,073
Reyhanli 1	5,819
Dudere 1	5,380
Karahoyuk 1	4,796
Turkish Gulf Oil Co., Murefte 1	6,825
Mobil Exploration Mediterranean, Kuransa 1	12,539
N. V. Turkse Shell, Kandamis 1	12,040[3]
Samsat 1	3,265
Bugdisan 1	4,222
Tidewater Oil Co., Ebyat 1	11,684
Dirpu 1	4,588
Horzum 1	3,931
Turkiye Petrolleri A. O., Rasan 3	6,246
Total, 19 Wells	122,963
DRILLING DECEMBER 31, 1959	
Deilmann-Shell, Maltepe 1	....
Mobil Exploration Mediterranean, Sinan 1	....
Turkiye Petrolleri A. O., Sadak 1	....

[1]Shallow show. [2]Non-commercial shows. [3]Gas shows.

Concessions. The acreage situation remains about status quo. As of May 1960, the 16 oil companies operating in Turkey held 246 licenses covering 11,132,016 hectares (27,507,212 acres) compared with 236 licenses covering 10,779,057 hectares (26,635,050 acres) in 1958.

Refining. Turkish Petroleum Company charged an average of 6,977 barrels of crude daily in 1959 at the Batman refinery, running at full capacity. This plant is being enlarged to allow processing of about 10,500 barrels daily.

Construction has begun on the new 65,000 barrels daily Mersin refinery, located on the south (Mediterranean) coast, west of Iskenderun. Mobil, Shell and British Petroleum are jointly involved in this venture. Completion is scheduled for late 1961.

Late in 1959, California-Texas Oil Corp. signed an agreement by which Caltex is to build a 20,000 barrels daily refinery at Izmit, on the Sea of Marmara, south of Istanbul. Caltex will own 49 percent and will operate the refinery during the first 10 years. Turkish Petroleum owns 51 percent. The new refinery will cost $26 million and is expected to go on stream in January 1962. Caltex withdrew from the Mersin refinery project.

Pipe lines. Work is continuing on the NATO pipe lines projects in Turkey. But this work is for military petroleum products distribution purposes only.

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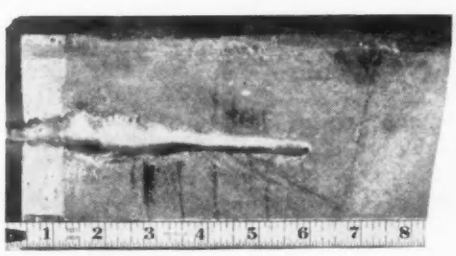
Maximum Temperature	350°	350°
Total Charge Weight	12 grams	20 grams
Av. Penetration (Berea Sandstone)	5.69"	7.45"
Av. Entrance Hole	13/32"	7/16"
Av. Well Flow Index	1.1+	1.44
Fill-up – 1' Gun, 5 1/2" Casing	1"	–
Fill-up – 1' Gun, 7" Casing	1/2"	1"



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Other Middle East . . . Abu Dhabi

field confirmed as commercial venture

EXPLORATORY ACTIVITY was yielding interesting results in some other areas of the Middle East. Abu Dhabi is well along toward becoming a producing country. The Umm Shaif offshore field has been declared a commercial venture by Abu Dhabi Marine Areas Ltd., after the third test on this structure found oil in the Araej limestone of the Jurassic at 9,600 feet. Previously-found oil was in the Thamama (Cretaceous) limestone at about 5,500 feet. Gas production had also been established in the Arab zone of the Jurassic. An extensive system of submarine pipe lines to be connected with a projected marine terminal at Das Island 20 miles away, was to be built.

Onshore on the Trucial Coast, a test on the Murban structure had indicated early this year that commercial oil deposits may exist there. Near the southern coast of the Arabian peninsula, Dhofar-Cities Service Petroleum Corporation continued its search for workable oil deposits, following up strong indications of oil announced several years ago in a structurally-complex area.

In Israel, five wells had indicated total gas reserves of about 35 billion cubic feet at Zohar in the Negev, 37 miles south of Jerusalem and 11 miles west of the Dead Sea. Production is from Jurassic limestone. This gas deposit has enhanced the Rakhma anticlinal chain of structures extending from Zohar nearly 50 miles to the southeast. A 6-inch gas pipe line was being laid to move Zohar gas to an industrial plant on the Dead Sea.

Wildcatting was being renewed in Lebanon in mid-1960. Exploration in Oman and Jordan continued without tangible results as of midyear.

ABU DHABI

ABU DHABI MARINE AREAS LIMITED confirmed its Umm Shaif discovery as a commercial find in 1960, and expected to begin crude oil production in two years. Umm Shaif 1 is located 60 miles offshore from Abu Dhabi in the Persian Gulf and 20 miles east of Das Island. It was completed in the summer of 1958, flowing about 2,400 barrels daily of 40° API. gravity crude from the lower Cretaceous Thamama limestone at about 5,500 feet.

Two stepouts of about 2 miles each, one east and one west of the discovery well, were completed in 1959. Umm Shaif 2 was drilled to 7,815 feet and found oil, but encountered relatively poor permeability in the pay horizon. But Umm Shaif 3 was drilled to 10,150 feet (total depth) and found

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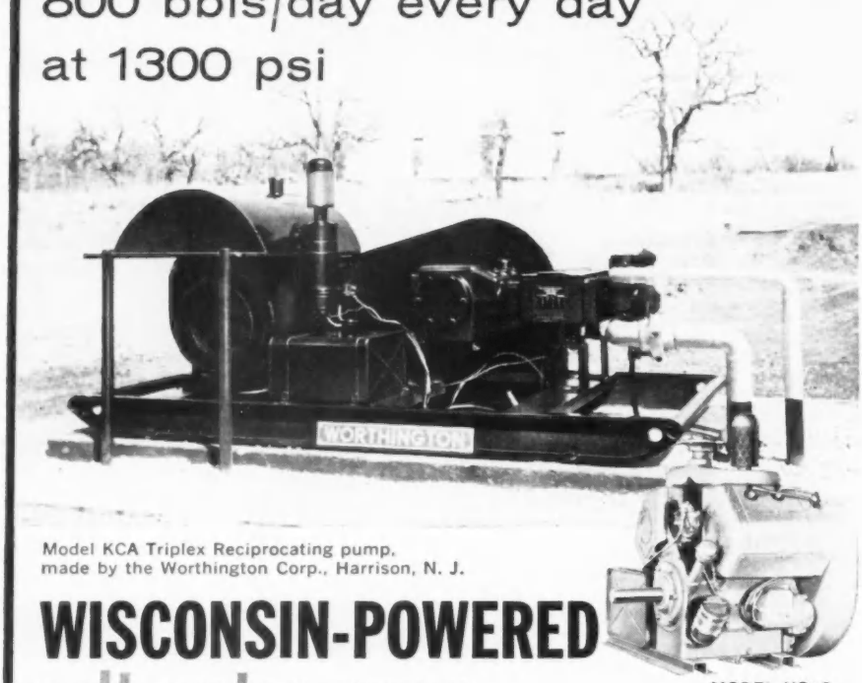

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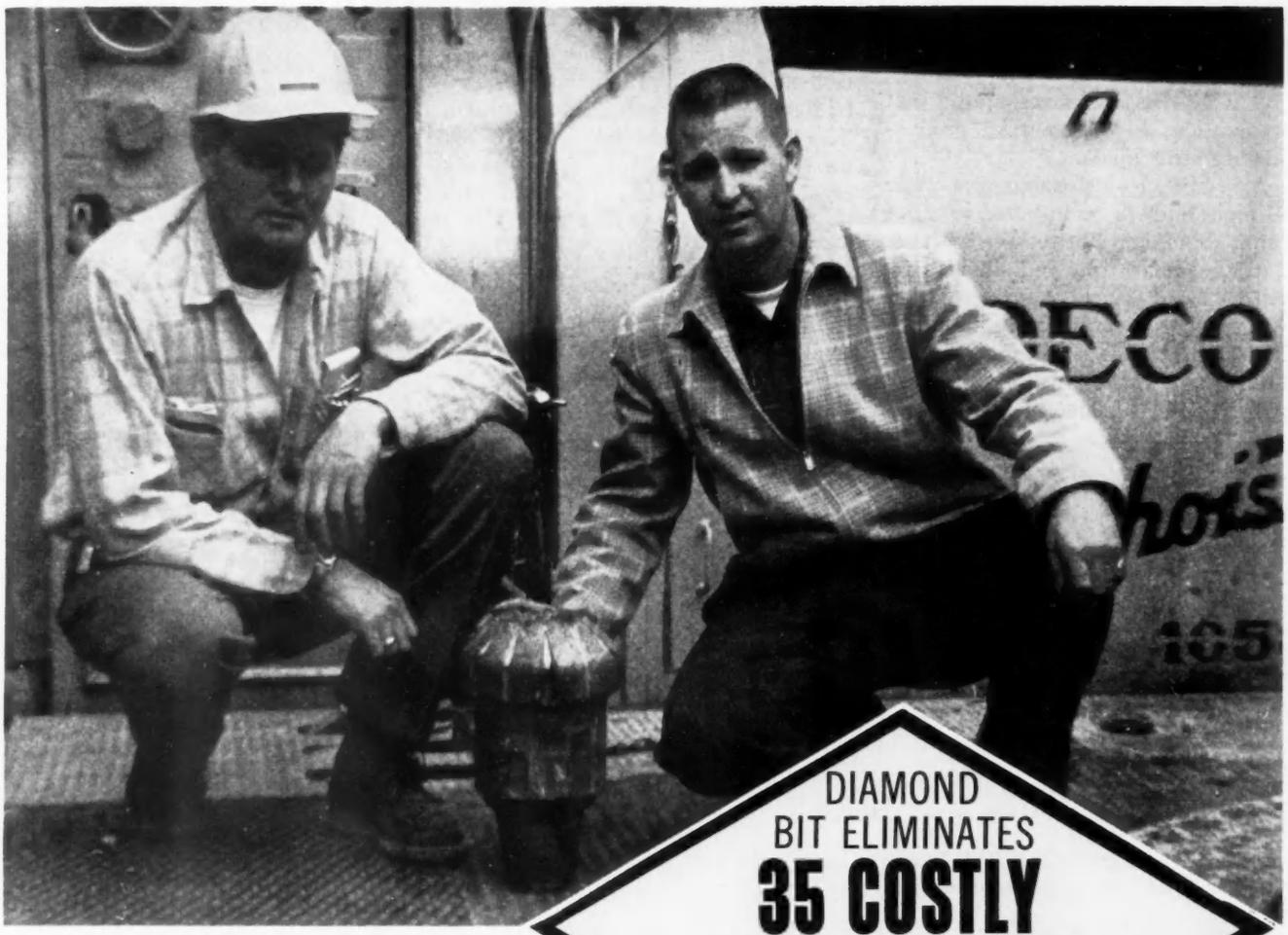

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The new record was set by a major oil company using an 8-11/32″ Christensen diamond drilling bit in Natrona County, Wyoming. After 28 days rotating on bottom the bit was pulled at approximately 16,000 feet and found to be in fair condition. The operating company estimated that 35 round trips and 35 conventional bits would have been needed to drill the same intervals and that the diamond bit saved 18 days.

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ABU DHABI

oil in the Araej limestone (Jurassic). Following tests, it was announced that preparations for commercial production are being made.

A 20-mile, 18-inch submarine crude oil pipe line will be installed to move Umm Shaif crude to Das Island. Gathering lines from individual wells will be 6- or 8-inch. A crude oil collecting platform will be built in the field and gas/oil separators, storage tanks and a tanker loading jetty will be built on Das Island.

Abu Dhabi Marine Areas, Ltd., is owned two-thirds by The British Petroleum Company, Ltd., and one-third by Compagnie Francaise des Petroles. The firm will use an unusual 810-dwt vessel called the "Muthmirah" to test the Umm Shaif wells. The "Muthmirah" carries a large flow tank and a 28 feet high separator on the deck aft, to allow flow tests. The ship is also equipped with separate cargo pumps to enable it to be used as an orthodox tanker when not in use for testing purposes.

"Adma Enterprise" at the site of Umm Shaif 1 well drilled in the Persian Gulf by Abu Dhabi Marine Areas Ltd., in which The British Petroleum Company has a two-thirds shareholding and Compagnie Francaise Petroles one-third.

ADEN PROTECTORATE

PETROLEUM CONCESSIONS LTD., continued its oil search in the Aden Protectorate in 1959. Three party-months of geological work, 3 crew-months of refraction seismograph and 12 crew-months of gravity work were done. It was not clear as of mid-1960 whether Petroleum Concessions will continue its work in the future.

No activity was reported in the Kamaran Islands in 1959.

At the Aden refinery, an average of 84,000 barrels of crude daily was processed last year, compared to the plant's 120,000 bpd crude-charging capacity. Bunkering facilities at Aden were expanded recently.

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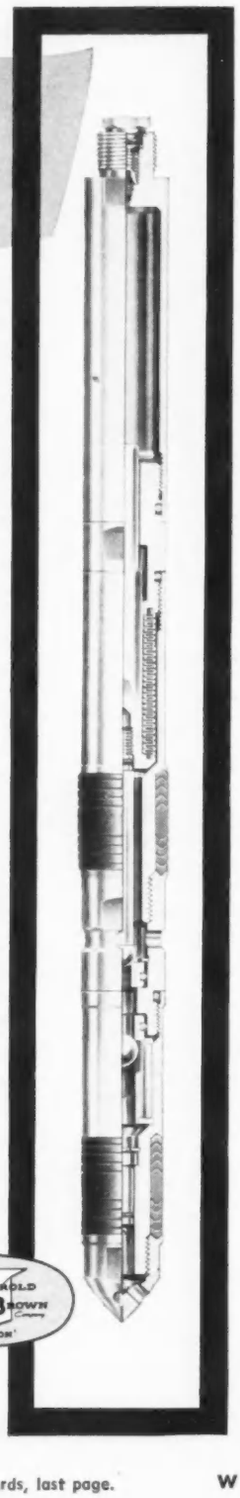

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DHOFAR

DHOFAR-CITIES SERVICE PETROLEUM CORP. is intensifying its exploration program this year. A deep test was drilling below 9,000 feet in May, and one seismic crew was working in the company's 32,000 square mile concession in extreme southern Arabia.

Three deep dry holes were completed last year, GM 1 in southeastern Dhofar, and M-10 and Qaurharu 1 in southeastern Dhofar. Some noncommercial oil shows were reported.

Five stratigraphic holes were completed also to a Cretaceous marker varying in depth down to 4,500 feet. Another deep test, Jarf 1 in southeastern Dhofar, was drilling below 5,000 feet at the end of December.

Two seismic crews worked during 1959. Some refraction work was done. Gravity work was also reported.

ISRAEL

ENCOURAGING RESULTS were being obtained from exploration programs in Israel in 1959 and 1960. A commercial gas field was confirmed at Zohar in the northern Negev last year, and there was hope for discovery of oil in this area. Unconfirmed reports in mid-1960 told of a new, deeper oil pay in Heletz field, enhancing possibilities of the coastal plain. About $40 million had been spent on exploration in Israel during the 1953-1959 period.

Crude oil production and drilling rates were up last year compared to 1958. An important milestone in pipe line construction was made at midyear 1960.

Production. Crude oil production, all from Heletz and Brur fields, increased to 2,500 barrels daily last year as shown in Table 1. Heletz was extended northward last year by well H24. However, pay sands here were thin, and H25 was being drilled on the northeast flank in hopes of finding better sand development. Heletz and Brur are drilled up on the regular pays (4,800-4,900 foot Nubian sandstone, close to the Jurassic-Cretaceous boundary).

Of 31 tests completed as of mid-1960, 24 wells, all pumpers, were producing (Table 2). Current production is 2,500 barrels daily, with 750 barrels of water also being produced by east flank wells. All wells are an 80-acre spacing. Bottom hole pressures are 1,660 psi, compared to 2,180 psi normal hydrostatic head at 4,800 feet.

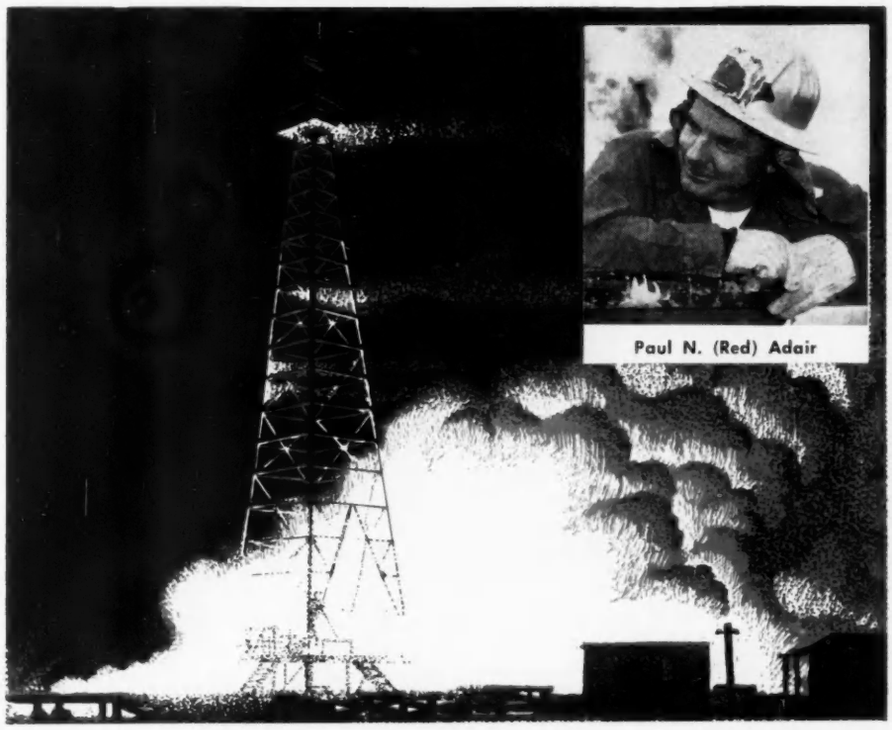
At midyear 1960, H25 was reported to have found oil production in a limestone horizon 150 feet below the regular pay. If confirmed, this find

TABLE 1—Crude Oil Production in Israel

Year	Barrels	Barrels Daily	% Rise
1959	912,500	2,500	40.4
1958	650,000	1,781	62.5
1957	400,000	1,096	164.9

TABLE 2—Producing Wells and Development Drilling in Israel in 1959

FIELD	Wells at End of 1959				Field Wells Drilled in 1959					Wells Drilling at Year End
	Producing			Shut In	Oil	Gas	Dry	Total	Footage	
	Flowing	Pumping	Total							
Heletz-Brur (Oil)	.....	24	24	.....	1	..	1	2	7,727	1
Zohar (Gas)	.....	.....	..	4	..	3	..	3	14,827	1
Total	.....	24	24	4	1	3	1	5	21,554	2



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may prove very significant to the Heletz-Brur area and to the coastal plain trend generally.

Drilling. Total full-hole and structural-stratigraphic drilling in Israel in 1959 amounted to 76,620 feet. This includes 21,554 feet of development drilling at Heletz, Brur and Zohar (Table 2); 34,061 feet in full-hole wildcats completed last year (Table 3), and 21,005 feet of core-hole work (Table 3). Total full-hole footage was 55,615, compared to 42,244 feet in 1958, and the all-time high of 136,044 feet in 1957.

TABLE 3—Exploratory Drilling in Israel in 1959

1. Full Hole Drilling

Operator[1]	Well	License	Spud Date	Completion Date	Total Depth, Feet[2]	Bottom in (Formation)	Remarks
INOC	Makhtesh Katan1	1/23	1-13-59	3-23-59	2,604	Jurassic	Dry
NIPC	Halutza 1	2/14	2- 8-59	5-13-59	7,677	Jurassic	Dry
INOC	Makhtesh Katan 2	1/23	3-31-59	12-13-59	9,317	Paleozoic	Dry. Minor oil, gas shows
INOC	Jordan 2	4/2	4-24-59	8-22-59	5,769	L. Cretaceous	Dry
INOC	Arava 1	4/7	6-14-59	8-17-59	8,694	Neogene?	Suspended

Total full hole wells completed: 4; suspended: 1; total full-hole footage: 34,061.

2. Stratigraphic and Structure Drilling

Operator[1]	Area	License	Holes	Footage
ICOC	Lachish	2/4	2	3,749
LIPC & IOPC	Caledonia	4/2	2	1,801
LIPC & IOPC	Beeri	2/7	3	5,643
LIPC & IOPC	Sumsum	2/8	1	1,125
PIOC & IMPI	Kurnub	1/9	1	1,132
LIPC & IOPC	Nir Am	2/7	1	988
LIPC & IOPC	Afik	2/7	1	6,567
Total, stratigraphic and structure drilling			11	21,005
Total, full-hole and stratigraphic-structural exploratory drilling			16	55,066

FOOTNOTES

[1]Company names are abbreviated as follows:
ICOC: Israel Continental Oil Co.
IMPI: Israel Mediterranean Petrolem Inc.
INOC: Israel National Oil Co.
IOFC: Israel Oil Prospectors Corp., Ltd.
LIPC: Lapidoth Israel Petroleum Corp.
NIPC: Naphtha Israel Petroleum Corp., Ltd.
PIOC: Pan Israel Oil Co.
[2] All depths are with reference to kelly bushings.

Zohar gas field. This new field is 37 miles due south of Jerusalem and 11 miles west of the Dead Sea. As of May 1960, five wells had indicated gas reserves of about 35 billion cubic feet. Zohar gas is found in three limestone members between shale breaks near the top of the Jurassic at about 4,000 feet. Pressures are subnormal. Gas is almost entirely methane. Fracture, rather than matrix, permeability governs production. An oil show was noted in Zohar 1, and Zohar 6 was being deepened in May (after finding two new gas zones) in hopes of finding oil production in sandstone.

Zohar's significance lies in proving commercial production in the northern Negev. And it enhances the Rakhma anticlinal chain of structures which extends nearly 50 miles to the southwest. Small structures as well as large ones are considered good prospects now.

Naphtha Co., Ltd., was expected to lay a 6-inch, $400,000 pipe line to

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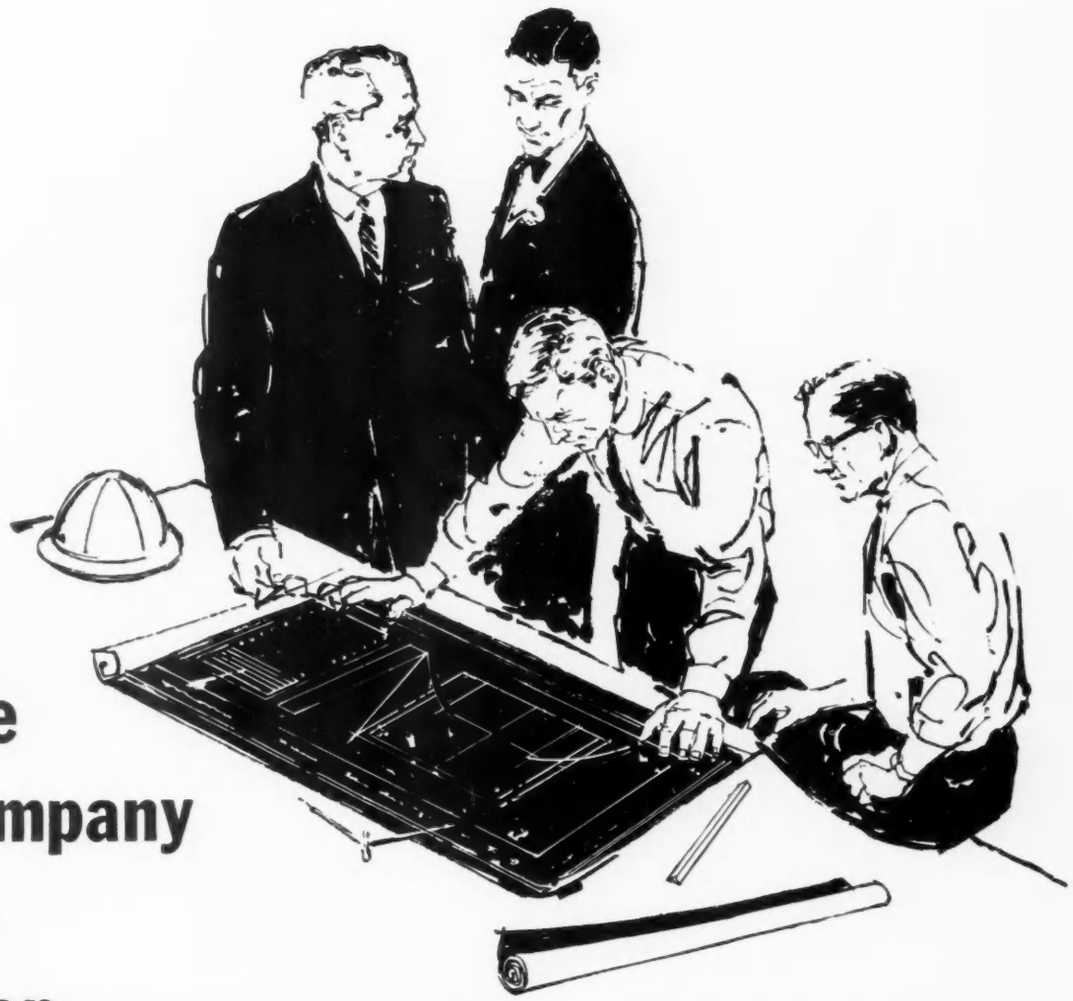

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deliver Zohar gas to an industrial plant on the Dead Sea.

Other exploration. Exploratory wells completed in 1959 are listed in Table 3.

Shallow gas possibilities along the southern coastal plain are being re-examined. Despite failure to establish commercial Neogene gas production in the Beeri area last year, new shallow gas probes were planned in 1960 in the Jaffe and Ramle areas. In addition, there was evidence that gravity lows may indicate (reef?) porosity beneath the Neogene onlap in the coastal plain.

Six companies were actively searching for oil and gas in Israel at the start of 1959. A total of 35 licenses covering 2,767,547 acres were in force as of January 1.

Geophysical activity in 1959 amounted to 11 seismic and 2 gravity crew-months. Seismic work was centered on the Beeri-Saad and other southern coastal plain areas. The search for suitable structures for Jurassic and Triassic prospects was to continue in this area. Previous seismic "no-record" areas may be reworked, using improved techniques. A gravity survey began in November to provide full coverage of the Beersheba Basin.

Pipe lines. The new 16-inch crude oil pipe line system from the port of Elath on the Gulf of Aqaba to the Haifa refinery was being completed in June. A 150-mile, 8-inch section from Elath to Beersheba was being replaced. Initial capacity of the new system will be 35,000 barrels daily, to be increased later by addition of new pumping stations to more than 100,000 bpd if needed.

Refining. The Consolidated Refineries, Ltd., plant at Haifa continued to run about 30,000 barrels of crude daily in 1959. Charging capacity is about 85,000 bpd.

JORDAN

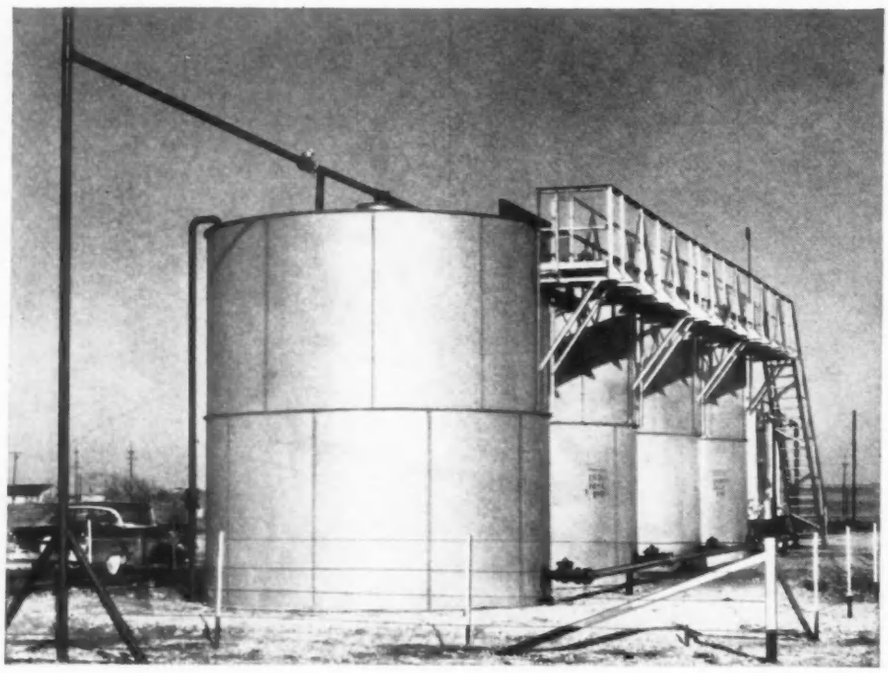
PHILLIPS PETROLEUM CO. continued efforts to find oil in Jordan. The company completed three dry holes last year.

Halhul 1, about 10 miles south-southwest of Jerusalem, was abandoned at 6,010 feet early in 1959, having been spudded in June 1958. Suweileh 1, located 10 miles northwest of Amman, bottomed at 7,639 feet. Jordan Valley 1 was drilled to 3,600 feet. No wells were being drilled at the end of December.

Phillips added about 435,500 acres to its concession last year. The new acreage was adjacent to and south of the Dead Sea and along the Israel border. Including this new acreage, Phillips held about 8,135,000 acres at the end of 1959.

LEBANON

GEWERKSCHAFT ELWERATH, the West German firm, has acquired a 50 percent interest in the Compagnie Libanaise des Petroles 75-year concession covering about 1,900 square miles in Lebanon. Involved are tracts in Bekaa, a high valley between Lebanon



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LEBANON

and Antilebanon, and in coastal areas including the vicinity of Sidon. Seismic work began in July 1959, and continued through end of December.

A wildcat was to be spudded at a location east of Hermil in mid-1960.

OMAN

PETROLEUM DEVELOPMENT (OMAN), LTD., an IPC affiliate, completed a dry hole, Ghaba 1, located 50 miles northwest of Khaluf at 12,661 feet in March 1959. This test was reported drilling below 12,275 feet at the start of last year. The next test, Haima 1, about 115 miles south-southwest of Ghaba 1, was spudded in May 1959, reached 11,504 feet on December 31, and was abandoned in February 1960, at 11,255 feet. A total of 11,890 feet of hole was drilled in Oman last year.

In 1960, there were reports of U.S., BP and French interests pulling out of the Oman venture, with their interests being acquired by the Shell group and Gulbenkian interests.

TRUCIAL COAST

PETROLEUM DEVELOPMENT (TRUCIAL COAST), LTD., (PD [TC]), an IPC affiliate, continued its oil search in 1959 and 1960, particularly in the Murban area. Murban 2, reported drilling at 5,888 at the start of 1959, reached total depth of 10,585 feet in July 1959. Work then commenced on Murban 3, about seven miles west of 2. Murban 3 reached 2,385 feet at the end of December. PD(TC) drilled 7,082 feet of hole last year.

On April 14, 1960, the company reported that several interesting shows of oil had been encountered below 8,400 feet. Testing was to continue, to determine the extent of the oil in the Murban structure.

PD(TC) and Petroleum Development (Oman), conducted a total of 15 crew-months of geological work, 38 party-months of seismic reflection, 34 crew-months of gravity work and 12 party-months of surface magnetics in 1959.

Far East Countries Push Oil and Gas Development

Lucrative new discovery at Cambay in western India highlights progress during 1959-60

IMPORTANT PROGRESS was made in the Far East in 1959-1960. The oriental nations effectively made strong efforts to develop domestic oil and gas sources to fuel stronger economies.

The development of a lucrative new oil province at Cambay in western India was of signal importance. In Assam, new production, transmission, and refining facilities were being built to place Nahorkatiya and Moran fields on production. They were expected to boost Assam's oil production sixfold by 1962.

In West Pakistan, natural gas reserves were being re-evaluated, due to the discovery of a cluster of smaller gas fields around the 5-trillion-cf deposit at Sui. Natural gas was satisfying about 70 percent of West Pakistan's industrial fuel needs. New oil discoveries in the Potwar plateau region by Attock Oil Co. heralded a change in luck of the frustrating oil search of recent years.

Burma's oil industry is becoming more important. In Red China, exploration is showing favorable results, with entirely new oil provinces coming into production. In Japan, exploration for onshore gas and offshore oil is booming.

This wildcat in Yamagata Prefecture in northwestern Honshu Island, Japan, typifies exploration along the coastal belt which is also being conducted offshore in the Sea of Japan. An important oil discovery was made at the location shown in February 1958, and new discoveries were being made in Yamagata and neighboring prefectures in 1959 and 1960. A total of 182 completions were reported during the first half of 1960 in Japan, and 375 wells were expected to be completed this year.

Afghanistan...

wildcat find reported

THE OIL POTENTIAL of northern Afghanistan appeared in more tangible terms in mid-1960. According to Soviet diplomatic sources, a wildcat at Aq-Shah struck oil in April. The location is north of the Hindu Kush mountains, 40 miles south of the Oxus River separating Afghanistan from Russia, and 75 miles northeast of Sar-I-Pul, where oil shows were encountered in previous drilling. Soviet participation in oil exploration in Afghanistan is limited to the northern strip involved in a 1929 treaty between the two nations.

Otherwise, little information has been released concerning activities of Russian and Czech technicians who are operating exploration programs in northern Afghanistan. Soviet drilling crews reportedly completed the first deep test at Sar-I-Pul in March 1959.

Map of Afghanistan shows the location of an oil discovery reported in mid-1960 by Russian diplomatic sources, near the town of Aq Shah. Previous tests at Sar-I-Pul, about 75 miles southwestward, encountered oil and gas shows. Northern Afghanistan is closed to geodetic work by western interests by an Afghan-Soviet treaty of 1929, forbidding work by foreign interests in border areas that could be construed as espionage. South of the border zone, aerial photography has been completed. Ground control was provided by Shoran triangulation stations shown, located on mountain tops.

Petroleum law. The Petroleum Law for Afghanistan was approved by the Cabinet Committee late in 1959. This law is intended to apply to Afghan territory outside the northern strip, and is essentially the same one recommended by Dr. Ralph L. Miller and David Cerkel of the United States Geological Survey with certain revisions made by the Afghan Cabinet Committee. It was assumed that the

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*U. S. Patent No. 2,732,906

AFGHANISTAN

law would take effect in 1960 after approval by the legislature and signature by the King.

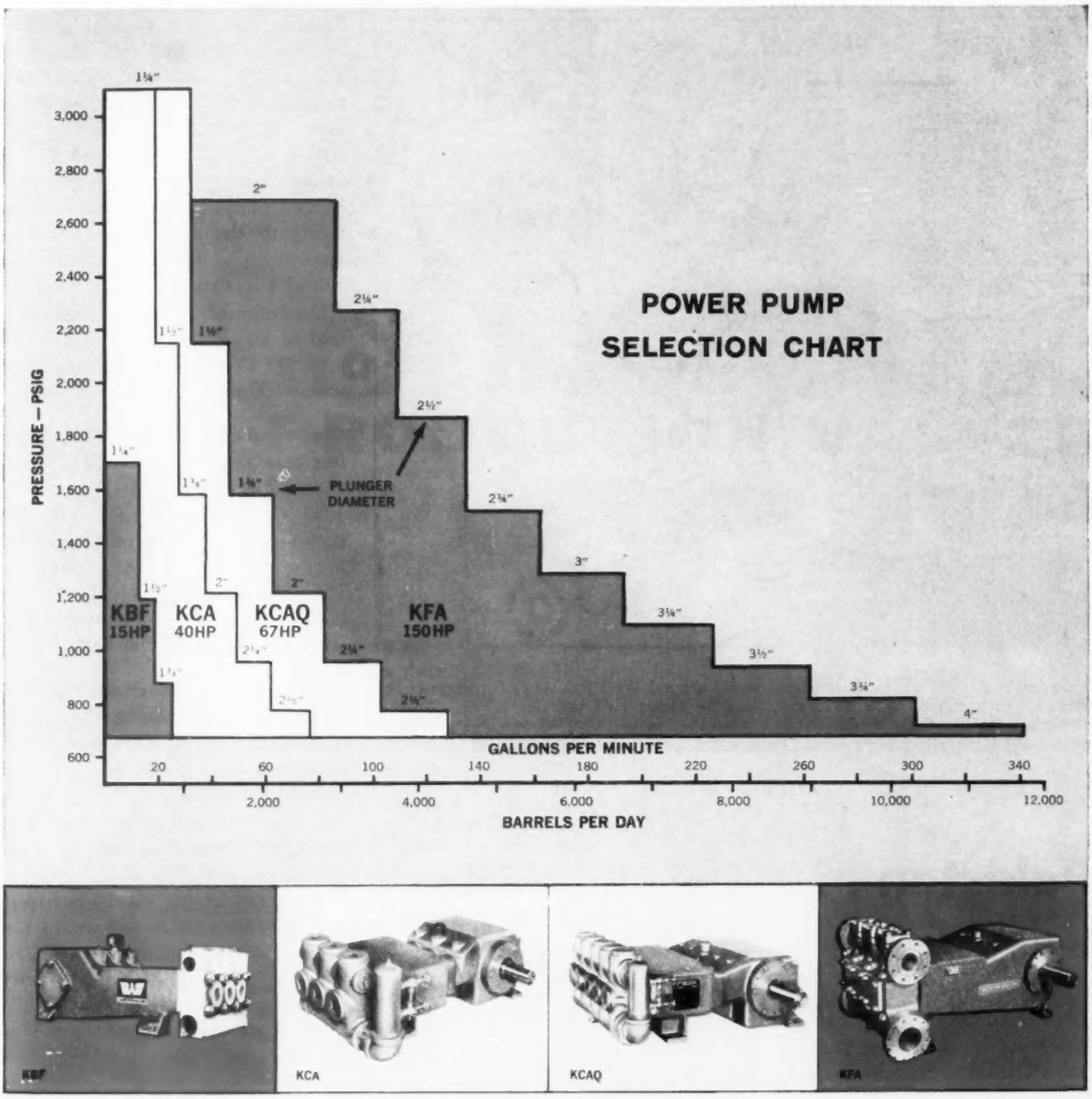
Investment law. Afghanistan enacted its "Law encouraging investment of private foreign capital" late in 1959. It includes numerous liberal provisions. Foreign capital imported is to be invested in industry, mining, transport and communications, among other specified categories. No discrimination shall be made between foreign and indigenous capital in levying taxes and duties. Leases on land necessary for new enterprises will be granted for long periods on liberal terms; or foreign enterprises may purchase land required for fixed assets. Capital invested may be repatriated after five years under certain circumstances. An investment committee is to be formed in the Ministry of Commerce. The Minister of Commerce is chairman, and the Minister of Mines and Industries is a member.

Aerial survey. Aerial mapping of Afghanistan outside the northern border strip is nearly completed. Fairchild Aerial Surveys, Inc., is making controlled mosaics for the Afghan government of two-thirds of the area at a scale of 1:50,000 and the rest at 1:100,000. Topographic maps at the former scale are contoured at 25-meter intervals.

Horizontal control was provided by a network of 12 Shoran ground control stations located on mountain tops selected for maximum aerial coverage. Vertical control was established by three-wire leveling over 2,150 miles of rugged country, tying on the northern edge to similar levels already established by Russian mappers. Control is described as first-order in accuracy.

Photographic operations were conducted at 32,000 feet. Some mountains in Afghanistan are 24,000 feet high. B-17 aircraft based at Kandahar were used. Photographic coverage was completed late in 1959.

This discussion of the aerial survey is taken from a paper entitled "Making a map of Afghanistan" by Milton Glicken of Fairchild, presented at the twenty-sixth annual meeting of the American Society of Photogrammetry, March 25, 1960. This paper is to be published in the Society's journal, *Photogrammetric Engineering.*



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These four pumps—each available in several interchangeable plunger sizes—allow you to buy the most economical amount of pump for your particular application. Should you require pumps of more than one rating, you save money on spares because many parts are interchangeable in the Worthington line.

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To learn more, contact your Worthington distributor or write to: Worthington Corporation, Section 108-36E, Harrison, New Jersey, U.S.A.

WORTHINGTON

A cluster of natural gas fields has been found around West Pakistan's 5-trillion-cf Sui field. Mari, a major 1959 discovery, may be about half the size of Sui. Farther northeast, the old Potwar plateau area continues to yield all of Pakistan's oil, and Attock Oil Company has made an important new oil discovery at Karsal.

Pakistan . . . facilities being developed to boost Sui gas field productive capacity

NATURAL GAS continues to show an increasing impact on Pakistan's economy. Facilities to boost productive capacity of West Pakistan's huge Sui gas field are being developed. A group of smaller gas fields around Sui have been located in recent years. The West Pakistan pipe line gas transmission system is being lengthened.

Sui gas is meeting almost 70 percent of West Pakistan's industrial fuel needs this year, and carbon black and other petrochemical plants were being planned to further a gas-based industrial setup.

In East Pakistan, plans were also being made to utilize gas from Sylhet and Chhatak fields.

Oil production, though still restricted to the old Potwar Plateau area in the extreme northwest, is increasing. The following events lent encouragement to the crude oil outlook in 1960:

• Pakistan Petroleum Limited (PPL), completed Karsal 3, located west of Balkassar field, for 800 to 1,000 barrels daily. This well was completed late in 1959, and was being tested early in 1960. The crude is of the same quality as Balkassar (25.7° API gravity). Karsal 3 was drilled to 11,664 feet in Eocene limestone. Increased oil production in Pakistan owing to the new discovery may amount to as much as 20 percent. Karsal 4 was rigging up in April.

• Unconfirmed reports in mid-1960 told of an oil discovery by The Attock Oil Co., Limited, at Dhalliang, about 100 miles from Rawalpindi.

TABLE 1—Oil and Gas Production, Producing Wells, and Drilling in Pakistan

Crude Oil Production, Barrels	
Total in 1959	2,093,622
Total in 1958	2,046,709
Daily Average in 1959	5,736
Daily Average in 1958	5,607
Percent Increase, 1959–1958	2.
***Natural Gas Production, in Thousand Cubic Feet**	
Total in 1959	17,414,220
Total in 1958	15,202,000
Daily Average in 1959	47,710
Daily Average in 1958	41,650
Percent Increase, 1959–1958	14.5
Oil Producing Wells at End of 1959	
Flowing	25
Pumping	65
Gas Producing Wells at End of 1959	**6**
Wells Completed in 1959	**9**
Oil	1
Gas	3
Dry	5
Footage Drilled in 1959	**87,048**
Wells Drilling at End of 1959	**4**

*Raw gas offtake from Sui field only. Does not include gas production from oil wells.

Crude oil production. Oil output last year amounted to 2,093,622 barrels (5,736 daily), a small gain over 1958 (Table 1). Attock Oil Co. reported 1,597,522 barrels produced last year, and Pakistan Petroleum, Limited, 496,100 barrels. Production is from Joya Mair, Balkassar, Dhulian, Khaur and Karsal fields.

Natural gas production. Raw gas offtake at Sui amounted to 17,414 MMcf in 1959, an average of 47,710 Mcf daily (Table 1), a larger yield than in 1958. Natural gas production at Sui is expected to increase to 23 billion cubic feet this year, or about 63 million cubic feet daily.

Deliveries of gas via 16-inch pipe line in 1959 were as follows: to Karachi, 9,791 MMcf; to Multan, 1,048 MMcf; and to Rohri, Khairpur, Hyderabad, Nawabshah and Dabeji, 4,455 MMcf. The anticipated increase in 1960 was expected to be spread proportionately among consuming centers, except that deliveries to Multan are expected to quadruple this year.

Production has been from 6 wells, including 4 on production regularly and 2 on standby. PPL was drilling Sui 7 in 1960, and was coring the limestone field pay horizon in May.

A small condensate plant was completed at Sui in October 1959, to produce about 500 barrels a month for local use. In mid-1960, Sui Gas Transmission Co. was planning to double the capacity of its gas purification plant at Sui field.

Drilling rates last year were comparable to those of 1958. There were 9

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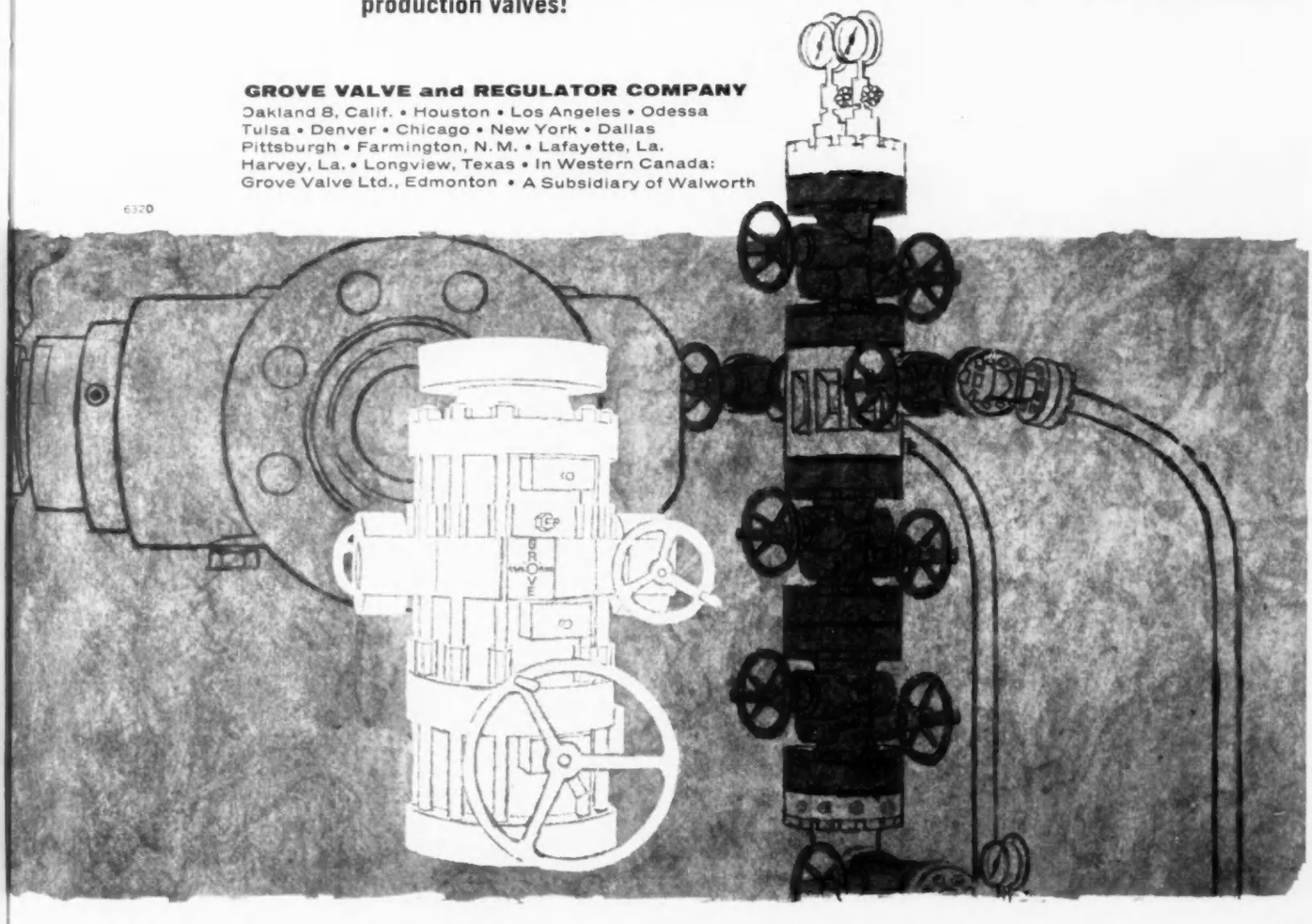

completions, including the Karsal 3 oil well, 3 gas wells, and 5 dry holes; 87,048 feet of hole was drilled. Four wells were being drilled at the end of the year and another was suspended.

Exploration. The year's most significant discovery was at Mari in West Pakistan, 65 miles southeast of Sui field. Pak-Stanvac Petroleum Project completed Mari 3 on September 28, at 9,628 feet (total depth). A major gas reserve about half the size of Sui (Table 2), was located in the Mari limestone (lower Tertiary), lying slightly higher in the section than the Ranikot formation. Productive depth at Mari is about 2,700 feet. Mari gas is about 30 percent non-combustible and awaits a market. However, increasing reserves in the area enhance market prospects.

TABLE 2—Natural Gas Reserves in Pakistan, April 1, 1960

Field	Raw Gas Reserves in MMcf	% of Raw Gas Combustible
West Pakistan		
Sui	5,000,000	89
Mari	2,800,000	70
Uch	2,500,000	29
Khairpur	250,000	17
Kandhkot	200,000	[1]
Zin	100,000	48
Mazarani	30,000	[2]
East Pakistan		
Sylhet	280,000	99
Chhatak	20,000	[2]

[1] Unspecified, but gas has high N_2 content.
[2] Not available.

PPL found some high nitrogen content gas at Kandhkot 1, located 25 miles south of Sui field. Total depth was 6,821 feet. Jointly with Hunt International Petroleum Co., PPL completed Mazarani 1, about 90 miles west of Khairpur, at 10,111 feet (total depth).

Wells drilled prior to 1958 at Zin, about 35 miles northwest of Sui, and at Uch, 30 miles west of Sui, encountered gas shows which are being re-evaluated in the hope of greater future gas use in Pakistan.

In addition to operators already mentioned, Pakistan Shell Oil Co., Ltd., Pakistan Sun Oil Co., and Tidewater Oil Co. are also active in exploration in West Pakistan.

Pipe lines. Plans are progressing to extend the eastern segment of the large-diameter Sui Gas Transmission Co. system an additional 200 miles northeast of Multan to Lyallpur and Lahore.

PPL is building an 11-mile, 8-inch gas line in East Pakistan from Sylhet field to a fertilizer plant at Fenchuganj. An 11-mile, 4-inch line was also being built in mid-1960 from the Chhatak gas field (discovered early in 1959), 25 miles north of Sylhet, to supply gas to a cement factory.

Attock Oil Co. was laying a 35-mile extension to move surplus gas from the Morgah refinery near Rawalpindi to a cement plant in January 1960.

Refining. Attock refined an average of 5,519 barrels of crude daily in 1959, at Morgah last year, against 5,223 bpd in 1958.

A new $35 million, 32,000 barrels daily refinery is being built at Korangi, 6 miles east of Karachi on the Indian Ocean. It will operate on imported crude. Stanvac, Caltex, Royal Dutch Shell and Burmah Oil Co. interests are involved. Completion is scheduled for 1962.

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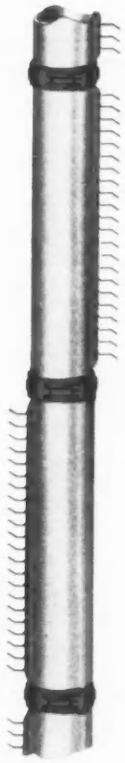

Roto Wall Cleaner installed with EZ Lok Clamps

HALLIBURTON ROTO WALL CLEANERS

... effectively "extend out" and clean off filter cake from the well bore. The stout metal fingers on each Roto Wall Cleaner are designed to remove filter cake as the casing is rotated.

HALLIBURTON RECIPO WALL CLEANERS

... provide another excellent means to clean the well bore of filter cake and help prevent cement channeling. Raising and lowering of the casing literally turns the heavy rubber fingers on this type cleaner "inside out" for maximum cleaning effectiveness.

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... are designed to support the cement column above porous formations, or to separate stages in a multiple stage cementing job.

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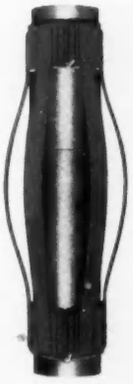

Model S-3 Centralizer

Cement Basket

EZ Lok Limit Clamp

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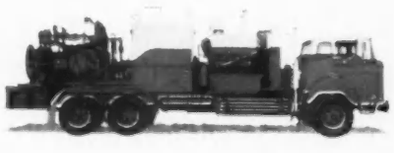

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India . . . vast development program under way

MOMENTOUS EVENTS were taking place in 1959 and 1960, as India girded to raise its living standards and to develop indigenous petroleum sources to fulfill as large a portion as possible of domestic fuel needs. New petroleum and natural gas rules were formulated late in 1959 to allow more private foreign companies to engage in exploration. Technicians from France, Italy and West Germany were assisting the Indian oil effort, in addition to private U.S. and Soviet-Rumanian government participation.

Natural gas is to be utilized more fully both for fuel and for manufacture of fertilizer. In India's third five-year plan, to be finalized early in 1961, oil and gas are expected to be stressed, much as the steel industry was pushed during the second five-year plan now being concluded.

Map of Assam area of northeast India shows oil fields and projected pipe line route to new refinery locations.

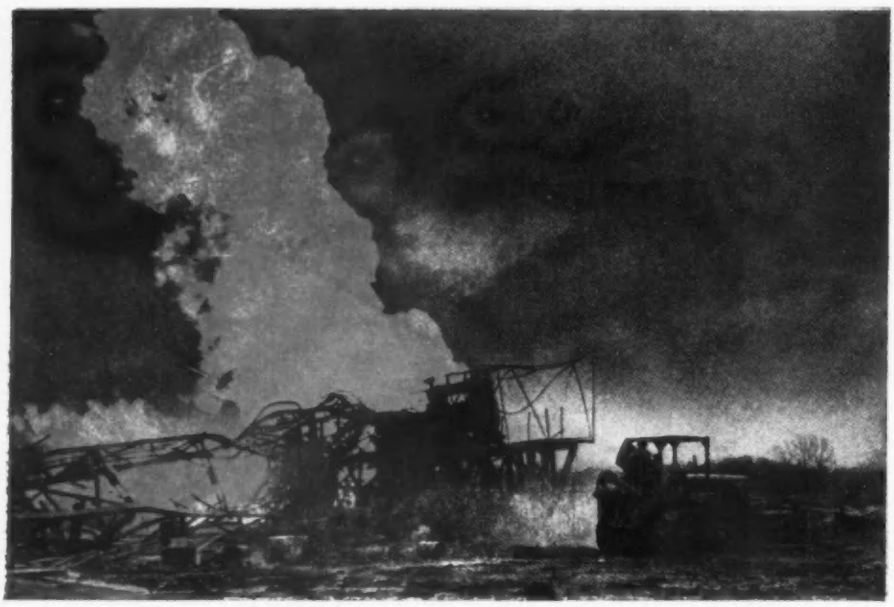
Salient 1959 statistics reflect increasing oil activity: crude oil production (all from Digboi field), 3,547,800 barrels or 9,720 daily, up 13 percent from 8,600 bpd of 1958; well completions, 21 in 1959 compared to 19 in 1958; footage drilled, 206,325 feet in 1959 against 178,000 in 1958.

Assam Oil Company. An increased amount of crude was produced at Digboi field last year and processed in Assam Oil Co. Ltd's Digboi refinery. Digboi field is now drilled up.

Oil India Private, Ltd., is a partnership between the Indian government and Burmah Oil and Assam Oil companies. It was incorporated on February 18, 1959, with an authorized equivalent capital of $105 million to develop crude oil sources in the Nahorkatiya, Hugrijan and Moran areas of Assam and to move this crude to refineries to be built and operated by the government at Gauhati in Assam and Barauni in Bihar. Burmah Oil has two-thirds and the government one-third of the equity capital.

Oil India Private completed 15 wells at Nahorkatiya, Hugrijan and Moran in 1959, including 12 oil wells, a gas well and two dry holes. Proven reserves are considered sufficient to allow production of 55,000 barrels daily.

As of February 16, 1960, a total of 66 wells had been completed at



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Another company says—"Since a pit level indicator is so important, take these precautions to get the most good out of it: Place the pit level recording instrument at or near *the driller's position on the derrick floor.*"

If the driller's responsibility is not misplaced, then he can recognize the danger signals that precede every blowout. With the Pit-O-Graf record before him, he can intelligently analyze the *rate* of gain or loss of mud as recorded and thereby direct his crew in the orderly control of the situation at hand. In this case the threatened blowout would become *one that does not happen.*

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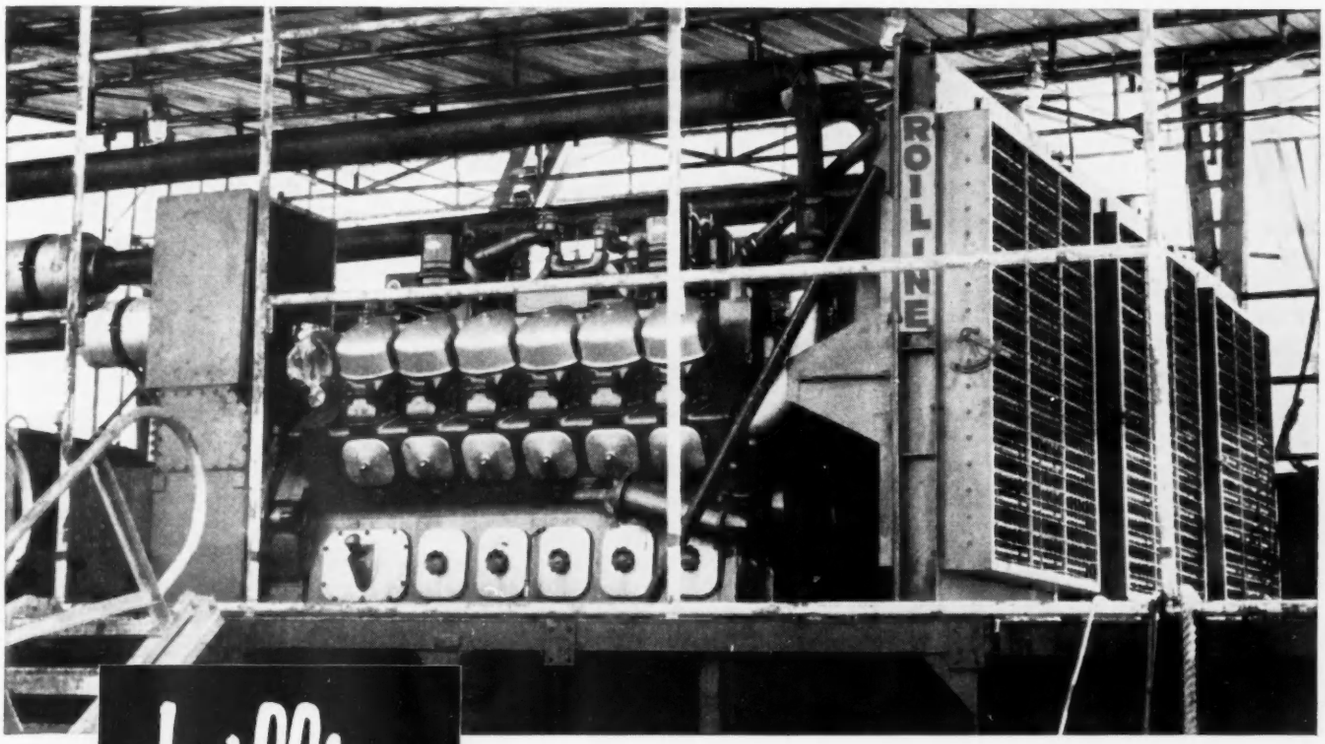

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Model	Bore and Stroke	No. of Cyls.	Displ. Cu. In.	Max. Torque Lb./Ft. @ RPM	Brake Horsepower at Engine Speeds Indicated 600	800	1000	1200	1400	1600	1800	2000	2200	2400
H570	4⅜ x 4¼	8	570	490....1800		68	89	109	129	148	168	186	202	216
H884	5⅜ x 4⅞	8	884	720....1600		105	133	162	190	219	247	271	285	295
F1500	6¾ x 7	6	1503	1170.... 600	134	176	214	230						
H2000	6¾ x 7	8	2004	1590.... 650	180	240	280	300						
L3000	6¾ x 7	12	3006	2420.... 650	275	360	435	460						
L3460	7¼ x 7	12	3468	2780.... 900	318	424	530	619	660 @ 1350 RPM					
L4000	7.54 x 7.5	12	4000	3280.... 800	385	500	615	706						

These are engine ratings on LP Gas . . . send for Power Chart with ratings for engines and complete power units operating on natural gas, LP Gas, and gasoline.

INDIA

Nahorkatiya and Moran. Nahorkatiya 55 and 56 were spudded last February and the location for 57 was staked.

Pipe lines. The Burmah Oil Co. (Pipe Lines), Ltd., was commissioned last year to design and oversee construction of a 720-mile pipeline system from Nahorkatiya and Moran fields to projected new refineries. Pipe (16-inch) for the 260-mile first stage from Nahorkatiya to the Noonmati refinery near Gauhati began to arrive in Assam late in 1959. A West German-Italian combine, comprising Mannesmann and ENI interests, was awarded the construction contract.

Construction of the first stage began last November. The 460-mile second stage from Gauhati to Barauni will be 14-inch. Completion of the first stage is to dovetail with completion of the 15,000 barrels-daily Noonmati refinery in April 1961. The second stage is to be completed by 1962, when the 40,000 barrels-daily Barauni refinery is slated for completion.

Natural gas utilization. A 2,600-hp gas turbine arrived in India in May 1960, the first of two such natural gas-burning units to be used to generate electric power at a station being built at Zaloni in the Nahorkatiya vicinity. Greater attention will be paid to use of natural gas in India in the future.

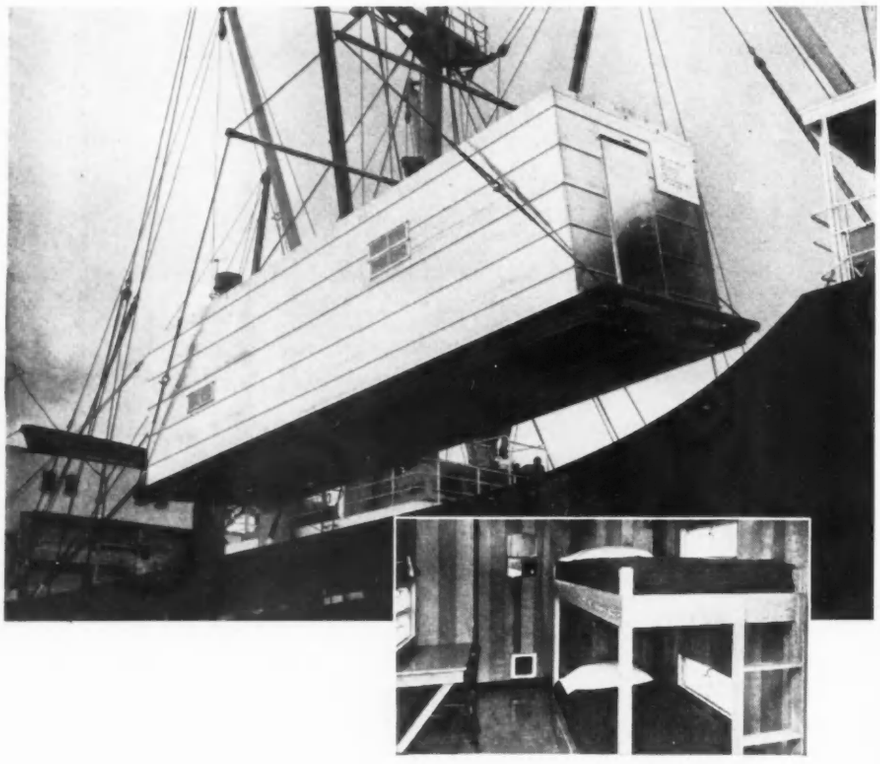
Government operations. Exploratory work by the Oil and Natural Gas Commission met with striking success in 1959 and 1960. In the Punjab, Jawalamukhi 1, which was spudded April 1, 1957, was completed on April 30, 1959, as a gas discovery from a horizon at 2,907 feet. The discovery well was drilled to 10,093 feet.

Oil discoveries in Cambay appeared to be much more important. Six test wells had been drilled as of May 31, 1960, on the Lunej structure; all of them had found oil. At Ankleswar, 100 miles south of the Lunej find and about 150 miles north of Bombay, oil was discovered in May 1960. Seismic structures are being drilled in this Tertiary-Cretaceous Basin where the pay horizons lie below the Deccan trap. Prospects at Baroda and Kosamba were also drilled. Gas was found in 1960 at Kosamba.

In addition to Jawalamukhi 1, three deep tests were completed by the Commission last year. Hoshiarpur 1 bottomed at 11,284 feet; Cambay 2 found total depth at 7,041 feet; and Sibsagar 1 bottomed at 12,504 feet. Total footage for these three tests was 30,829 feet of hole.

In mid-1959, the Commission was operating eight deep drilling rigs (5 Russian, 3 Rumanian). Two new rigs from the United States were being imported to help evaluate the promising discovery at Ankleswar.

In other exploration, work is being done in parts of the Himalayan foothills in the Punjab and Uttar Pardesh (UP); the Ganga valley of UP and Bihar; Rajasthan desert; the plains of Gujerat and Saurashtra; Kutch, Assam and parts of the east coast. Twenty geological parties, 8 gravity-magnetic crews and 8 seismic crews are working. The Commission did 130 party-months of surface geological work, 46 crew-months of seis-



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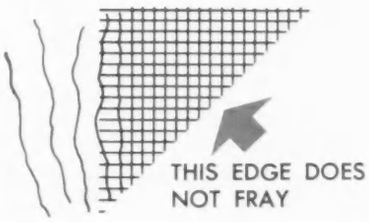

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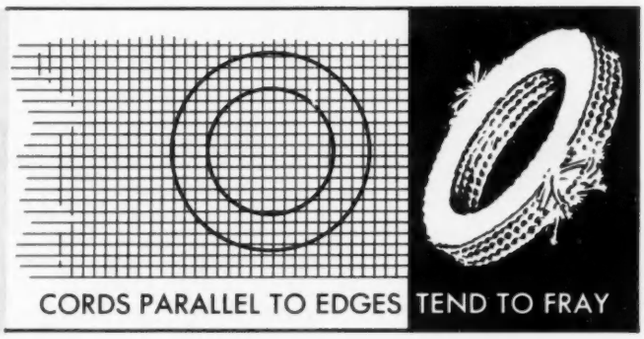

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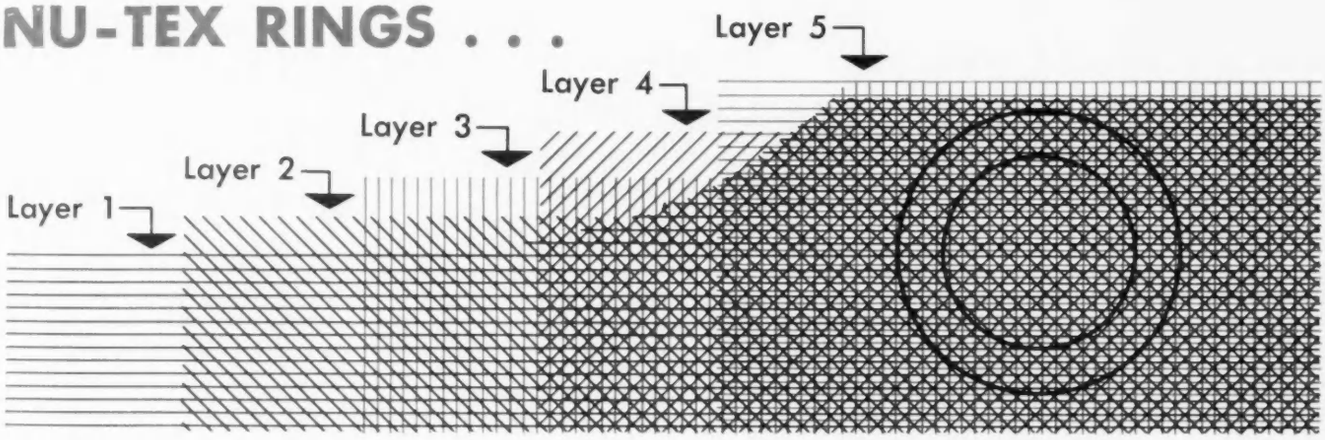

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INDIA

mic and 57 party-months of gravity-magnetic work last year.

The deep Hoshiarpur test in the Punjab was drilled on a structure indicated by gravity, magnetics and seismic. A deep test is being drilled on a structure at Disangmukh in Assam. The Cambay Basin is being worked in detail. Production in the Cambay region is expected to begin early next year and a refinery may be built to process the crude.

Standard-Vacuum Oil Company. Stanvac holds 75 percent interest in Indo-Stanvac Petroleum Project. Drilling continued in the West Bengal concession. Two dry holes were completed in 1959, Ranaghat 1 and Memari 1. The latter was abandoned last August at a total depth of 12,490 feet.

Stanvac's eighth wildcat, Port Canning 1, was being drilled at the end of 1959, near the south edge of the concession at 88° 39′ 15″ east longitude, 22° 19′ 28″ north latitude. At 13,259 feet, a high-pressure sand was encountered on February 3. Casing was to be run to allow testing. A rig was also being erected for a second test at Ranaghat.

Stanvac drilled 25,496 feet of hole last year and conducted 6.4 party-months of seismic investigations.

1959 Petroleum Rules. As of Nov. 25, 1959, the Indian government superseded and replaced its Petroleum Concession Rules of 1949, pursuant to sections 5 and 6 of the Oilfields Regulation and Development Act of 1948. The intention is to encourage participation of foreign capital.

Prospecting grant terms were simplified. An exclusive initial exploration *license* is to cover 3,000 square miles and endure for four years. However, both the size of area(s) and tenure of the license may be agreed otherwise. A *lease* is for producing operations, to cover 100 square miles for a 20-year period unless agreed otherwise. Initial fees and annual rentals on licenses are specified. Rentals increase each year.

Royalties on production are 10 percent of gross wellhead value, in cash or in kind at the government's option. If either price or amount produced are too low in the government's opinion, it may determine production rates and assess values based on local market prices—however, the operator may appeal to arbitration if dissatisfied.

Guarantee deposits are specified for licenses and leases. Licenses may be dropped all or in part at any time on two months advance notice. Leases may be dropped on written request to the state government. State governments have the right to suspend or cancel licenses and leases under certain conditions, including condemnation for public purposes.

In national emergencies, the government is entitled to all production on payment of fair market prices. Licenses and leases may be extended under conditions representing *force majeure*. The government has certain rights to enforce conservation.

Many highly important considerations are open to negotiation under these rules, including depletion and other tax matters, the government's share of profits, explicit renewal rights on licenses and leases, terms of leases, primary terms and sizes of areas and pipe line, refining, and marketing rights.

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Burma . . . crude oil output up 30 percent

RENEWED VIGOR was evident in Burma's oil industry in 1959 and 1960. Crude oil output increased 30 percent last year over 1958. Seismograph and gravity crews were active in 1959, and recent deep tests have found encouraging flows of gas. Domestic demand for petroleum products is mounting, spurring increased local crude oil production.

Crude Oil Production, Producing Wells, and Drilling in Burma in 1959

COMPANY	CRUDE OIL PRODUCTION IN 1959		Crude Producing Wells, End 1959	FIELD WELLS DRILLED IN 1959				Development footage drilled in 1959
	Total Barrels	Barrels Daily		Oil	Gas	Dry	Total	
Burma Oil Co. (1954) Ltd.	3,474,700	9,520	394	20*	1*	8*	29	87,900
Independent producers, Yenangyaung and other fields	417,500*	1,144*	†	†	†	†	†	†
Total	3,892,200	10,664	394	20	1	8	29	87,900

*Estimated. †Not available.

Production. Crude oil production, primarily from Chauk, Lanywa and Minbu fields, aggregated 3,892,200 barrels in 1959, an average of 10,664 barrels a day. Included are 3,474,700 barrels (9,520 daily) by The Burma Oil Company (1954), Ltd.) and an estimated 417,500 barrels (1,144 daily) by native operators. Hence output has increased abruptly over the 8,200 barrels daily produced in 1958, and 7,150 bpd in 1957.

Drilling. In Chauk field 26 wells were completed last year, some of them being deviated holes drilled to tap oil sands below the Irrawaddy River. In all, 29 development wells, involving 87,900 feet of hole, were completed in 1959.

Exploration. Three deep wildcats were instrumental in pushing the 1959 footage total to 122,700 feet. Total exploratory drilling footage reported for 1959 was 34,800 feet. Dedaye 1, Burma Oil's second test in the Irrawaddy delta, was completed last year as a dry hole at 10,928 feet (total depth). A minor gas flow was encountered. The third test, Payagon 1, located eight miles west of Kyaiklat (where a 12,000-foot hole was abandoned in December 1958), had been drilled to 13,108 feet by the end of 1959. Payagon 1 was the deepest hole drilled in Burma as of mid-1959.

Elaborate testing followed, with zones at 12,200 feet, 11,460 feet and 8,700 feet yielding water. However, a sand at 4,660 feet flowed 90 percent methane gas at 8 MMcf daily through a ½-inch choke. Closed-in surface pressure was 1,845 psi. If this find proves commercial, it will be the only gas production within 190 miles. The Pyaye structure, 190 miles to the north, supplies gas to a cement factory.

One deep Chauk field test was drilled to 8,828 feet in 1959, but found only minor shows associated with high-pressure water sands. However, Burma Oil Co. (1954), Ltd., completed Chauk 1,025 at 8,200 feet on March 23, 1960. Production tests indicated wet gas flowing at the daily rate of 3 MMcf from each of two zones at 6,840 and 7,320 feet, respec-

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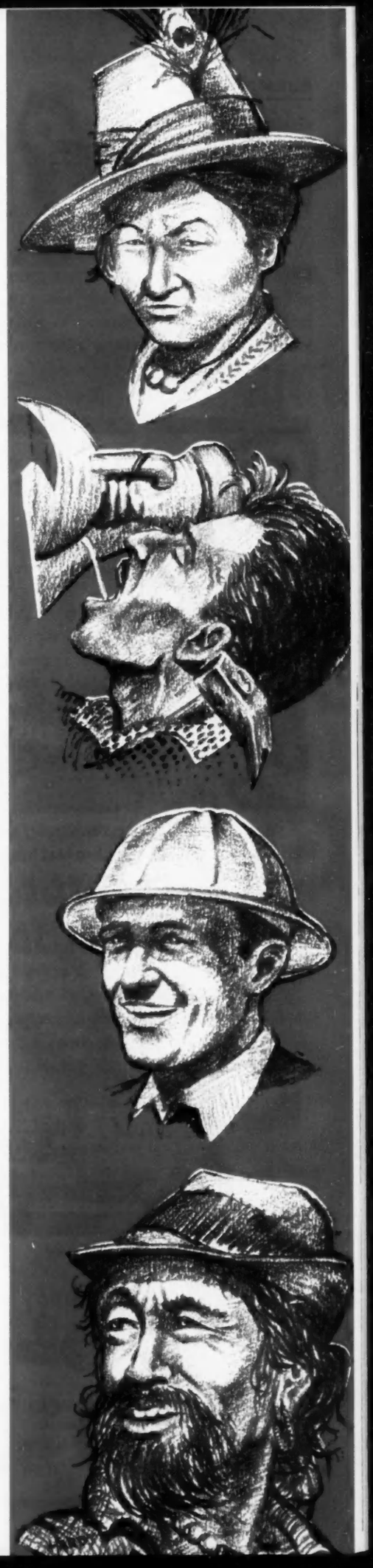

tively. Unlike the dry gas at Payagon, Chauk 1,025 indicated a gas cap with a possible oil column to be found by further drilling. Chauk 1,035, located 1,200 feet east-southeast of 1,025, was spudded on May 19. All previous Chauk field production has been obtained from 4,000 feet or shallower.

Efforts were also being made to establish deep production at Yenangyaung field. Yenangyaung 3,032 projected to 5,200 feet, was spudded on April 19, 1960, by Burma Oil (1954).

Additional wildcat drill sites at Yedwet, 20 miles east of Yenangyaung; at Kyun Nyogyi near Bogale, and at Tharrawaddy, in the Irrawaddy delta region, are expected to be drilled upon the granting of prospecting licenses by the government.

Twelve party-months of seismic work were undertaken last year in the Irrawaddy delta. Both reflection and refraction were done. A gravity party operated for nine months in areas east of Rangoon, near Ondwe, and west of Yenangyaung.

Government participation. The Burmese government was considering increasing its share in Burma Oil Company (1954) from 33⅓ to 51 percent. The 1954 agreement allows such an option.

Transportation. Apparently, efforts to rehabilitate the Yenangyaung-Chauk-Syriam pipe line system, destroyed during World War II, have been permanently abandoned. The Inland Waterways Transport Board (IWTB) maintains a fleet of six push-tow tugboat units, each consisting of a tug and four barges. These units have a capacity of 13,571 barrels during high water season and 9,762 barrels during low water. The round trip via the Irrawaddy River from Chauk to Syriam and back takes from 10 to 11 days.

OIL DEVELOPMENT IN BURMA

Crude oil production is being increased in Chauk and Yenangyaung fields. Deep drilling was under way at Yenangyaung in mid-1960. Wildcatting was also active in Irrawaddy delta. Assam oil fields in India are shown at extreme north and Pakistan's Sylhet and Chhatak gas fields lie to northwest.

Refining. Burma Oil Company (1954), Ltd., charged a daily average of 8,990 barrels of crude last year, including 4,810 barrels daily at Syriam and 4,180 at Chauk.

Newcomer in exploration. Application for exploration licenses has been made by General Exploration Company of California on 15,000

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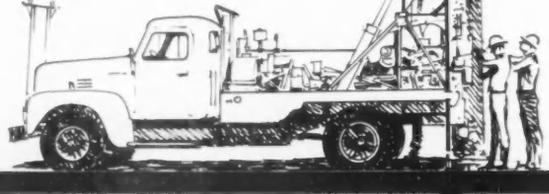

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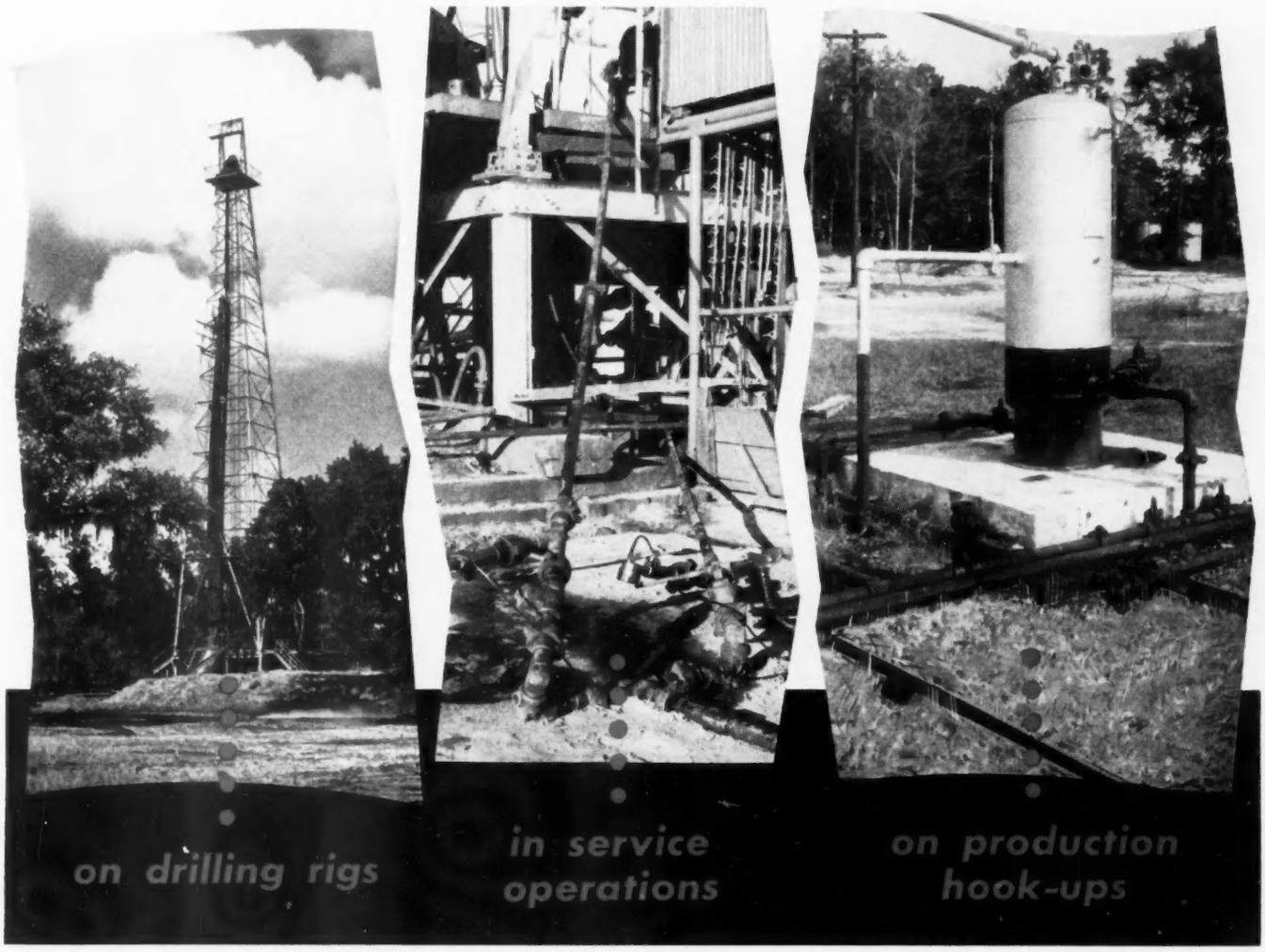

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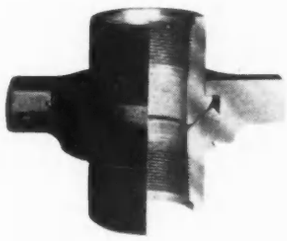

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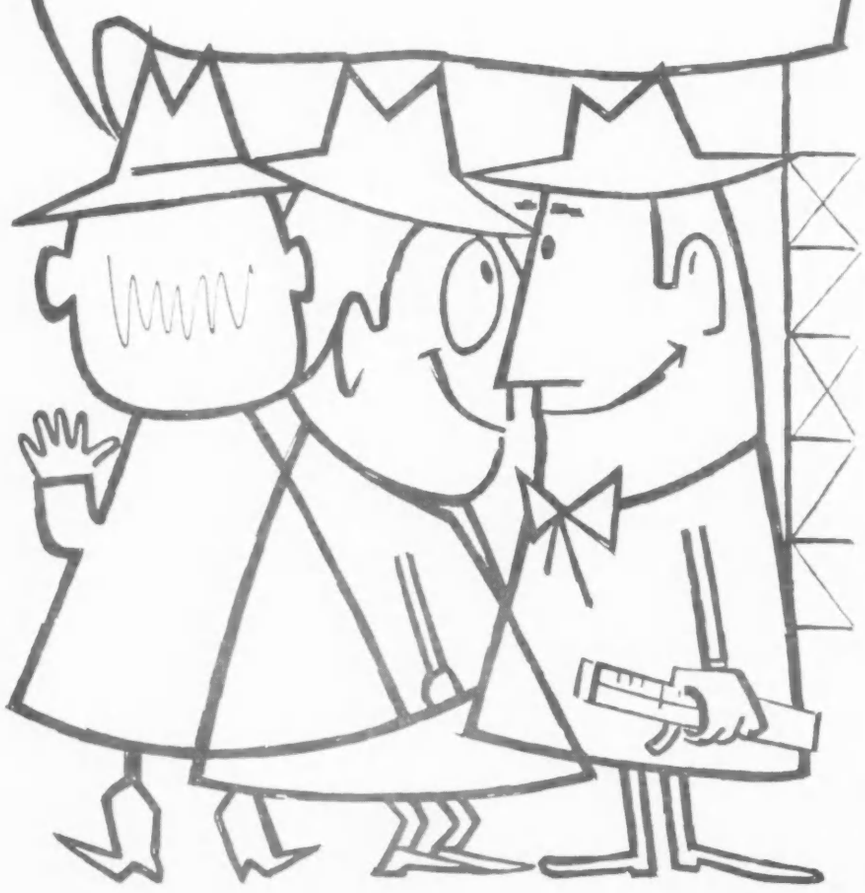

BURMA

square miles in Burma. Included are 12,000 square miles of the upper Irrawaddy Basin and 3,000 square miles offshore from the Irrawaddy delta. Geological interpretation has commenced on airphotos of the area obtained from the Burmese Department of Surveys.

In being allowed to apply for an exploration license in Burma, General Exploration reportedly becomes the first company, outside of Burmah Oil Co. to receive such a certificate since 1948, when Burma became independent.

Laos . . . exploration hits a snag

SOCIETIE D'ETUDES ET D'EXPLOITATIONS MINIERES DE L'INDOCHINE (SEEMI) was to receive two 5-year exploration permits in Laos (WORLD OIL, August 15, 1959, page 254).

Reports indicate that SEEMI had six months to finalize its agreement and commence exploration. But the unstable political situation had delayed both as of midyear 1960. The matter appeared to be in a suspended status at that time.

Thailand . . . Private oil search viewed

THE 25 SHALLOW WELLS completed by mid-1960 in the Mai Fang field were producing about 300 barrels of 16° API gravity crude daily. Production had been entering storage before the new 1,600 barrels daily Mai Fang refinery was completed earlier this year. This plant is able to operate on a 25-day month basis, running local crude.

The Thai government suspended all exploration during 1960 to examine the possibility of drilling operations being done by private interests. A number of proposals to this effect were being considered by a committee of Thai government ministers. Exploration programs, involving magnetic and other methods were being planned for 1961.

A private firm, International Chemical and Equipment Co., Ltd., of Bangkok is under contract with the

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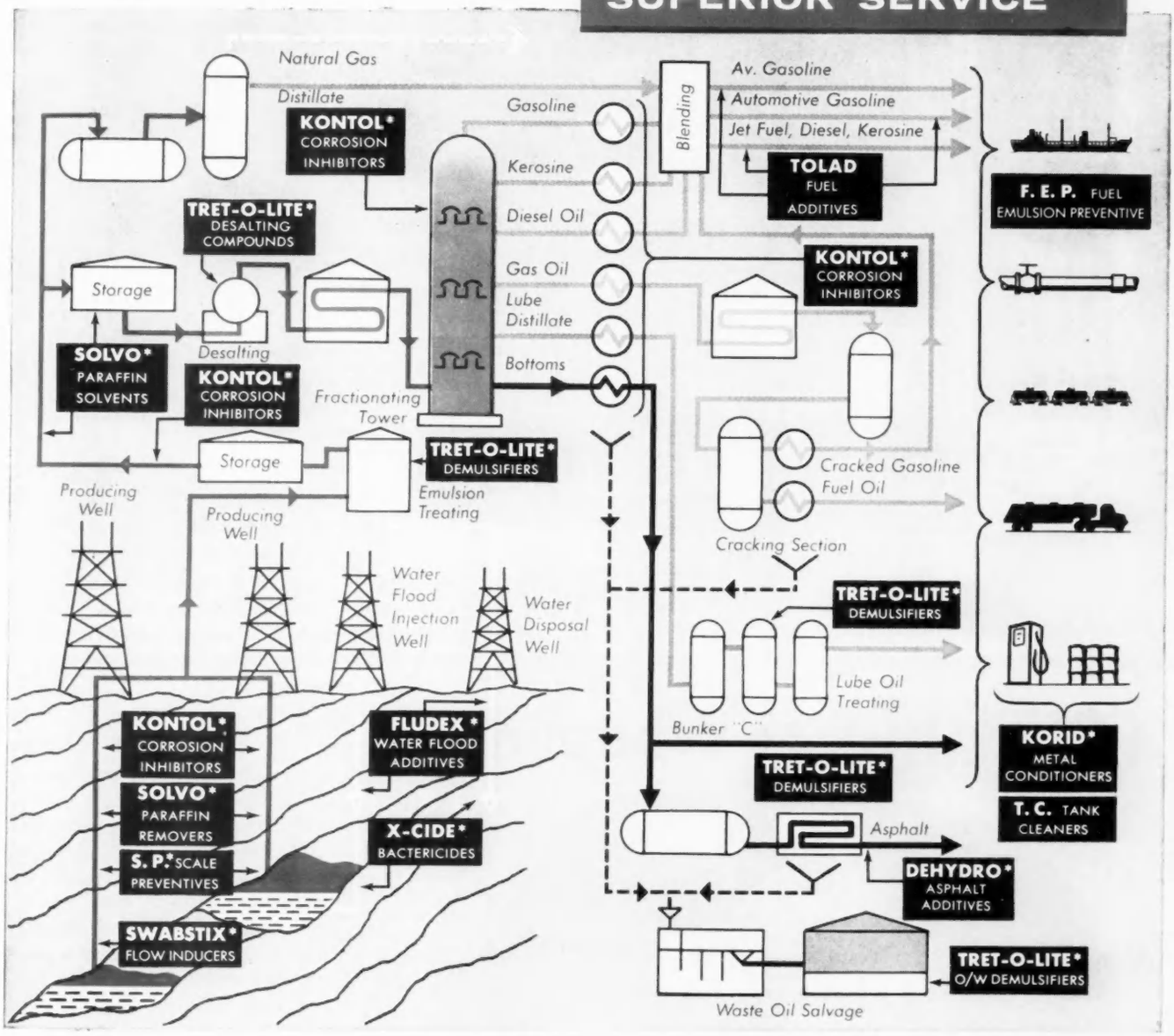

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The Province of Alberta has 220,000 square miles underlayed by sedimentary deposits. It will require one wildcat well for every 10 square miles to adequately explore this basin.

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Alberta is still an oil frontier.

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THAILAND

government to train operators for the small Mai Fang refinery.

Two refinery projects to operate on imported crude were being considered by the government. A projected 30,000 barrels daily refinery will be built by Standard Oil Co. (Indiana) if the government approves. There is another tentative project to build a 5,000 barrels daily plant for military and other government use.

China . . . production of 60,000 bpd reported

COMMUNIST CHINA claims a 1959 production figure of about 60,000 barrels daily, which if true, would amount to 21.9 million barrels. Although some of this production is shale oil, it is clear that crude oil production is increasing much faster than shale oil output. Red Chinese planners anticipate production of 5.2 million metric tons of oil in 1960, or about 100,000 barrels daily. Production rate reported in 1958 was 44,600 barrels a day.

Recent exploration indicates that China will become a major crude producer in the future. The Chinese are very optimistic as to possibilities in the Dzungarin Basin in Sinkiang province, the location of Karamai field. About 4,000 barrels daily were being moved in 1959 from Karamai to the Lanchow refinery via a newly-completed railroad. And a 90-mile pipe line was completed at the start of 1959, linking Karamai production with the Tushantzu refinery, 90 miles distant in northern Sinkiang, 125 miles west of Urumchi.

Chinese geologists report recent successful oil tests in the Tarim Basin in southern Sinkiang and also in the Turfan Basin south of Urumchi. A promising new oil field at "Flame Hills," is reported in Turfan, close to the Lanchow-Sinkiang railway.

The Tsaidam Basin, according to Communist claims, is proving exceedingly prolific. In five years more than 120 structures have been located. More than 300 tests have partially evaluated 40 of these features; 229 of the wells have reportedly found oil or gas. Lenghu is said to be the key production and development area,

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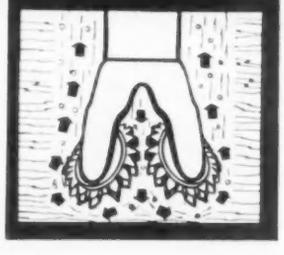

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CHINA

and is to be the terminus of a projected Lanchow-Chinghai railway, which would alleviate the extreme remoteness of the Tsaidam Basin area. The first refinery in Tsaidam was reported on stream as of August 1959. Production in the Basin was 7,200 barrels of crude daily.

Yumen district. The Yaerhhsia oil field, discovered in 1956, is reported to be larger than Laochunmiao field, long the backbone of China's oil producing industry. About 100 wells annually are said to be undergoing completion in this area.

Szechwan. Production from the central Szechwan oil field (WORLD OIL, August 15, 1959, pp. 254-256) was said to be averaging 2,700 barrels daily from 19 wells last year. The crude is moved to the Shanghai refinery for processing. However, refineries are now being built in Szechwan.

Chinese geologists are exploring many other areas, including the Ordos region of Inner Mongolia, eastern Szechwan, Kweichow province, Hainan Island and the Sungliao Plain of northeast China. The last named area is said to contain many promising structures in the area between the Sungari and Liao rivers. Mesozoic and Cenozoic strata are said to be prospective. The area is much closer to markets than are the Sinkiang and Tsaidam fields.

Refining. It is believed that most of the many new refineries are merely topping plants to fulfill local products needs. One of Red China's most urgent needs is sufficient aviation gasoline and jet fuel for its air force. Military needs are no doubt largely responsible for Red China's strong emphasis on oil exploration and development.

Outer Mongolia. The so-called "People's Republic of Mongolia," another Soviet satellite, produced about 50,000 metric tons of crude in 1956 (about 1,000 barrels daily), and has improved on this output since then, according to Russian sources. Products from the new Siberian Irkutsk refinery may be distributed in China via a railroad passing thru Outer Mongolia. The Mongolian Republic is also becoming a more important political link between Russia and China.

Taiwan . . . three likely structures discovered

PETROLEM EXPLORATION in Taiwan in 1959 was conducted in the foothills and on the western plains. Surface geology of 13 districts was mapped. An area of about 270 square miles was covered. Approximately 70 man-months were spent in the field. In the districts investigated, three structures were found worthy of exploratory drilling.

Drilling was conducted in 1959 in 12 wells, including 11 structural tests (9 in the foothills and 2 on the plains) and 1 old well deepened in Chinshui field. Of the 12 wells, 5 were completed by end of 1959, resulting in 4 dry holes and one producer. The producer and the deepened well are yielding mainly natural gas with some crude oil. Total footage of drilling in 1959 was about 39,000 feet.

Sedimentation studies were made in 12 districts scattered over the area between Miaoli and Taiwan as well as on some core samples taken from individual wells.

Seismic prospecting was carried out in 1959 in 9 districts in the western part of the island, in the area between Miaoli and Kaohsiung. Surveys involved 1,708 shot holes located at the profiles of a cumulative distance of about 267 miles.

One gravity crew has been organized and started its field work since October 1959. For experimental purposes, 486 points were surveyed in the northern part of Taiwan.

Crude oil production in Taiwan in 1959 totaled 13,046 barrels, an average of 36 barrels daily, compared with 41 bpd in 1958. The oil came from 34 wells, of which 7 were flowing and 27 pumping.

Natural gas production averaged 2,525,000 cubic feet per day in 1959, compared with 2,689,000 in 1958.

Crude oil runs to stills in 1959 in the Kaohsiung refinery of Chinese Petroleum Corp. totaled 7,310,333 barrels, an average of 20,028 bpd and 20 percent more than in 1958.

Crude Oil and Natural Gas Production, Producing Wells, and Drilling in Taiwan

FIELD	Crude Oil Production, Barrels		Natural Gas Production, 1,000 cu. ft.		Crude Oil Producing Wells in 1959			Gas Producing Wells, 1959	Wells Drilling, End of 1959
	Year 1959	Daily 1959	Year 1959	Year 1958	Flowing	Pumping	Total		
Chuhuangkeng	9,881	27	163,679	158,681	1	23	24	1	..
Chinshui	1,843	5	275,127	285,225	2	..	2	10	..
Chutung	100	..	187,291	163,203	..	..	..	7	..
Shantzechiao	1,046	3	662	866	..	2	2	..	..
Niushan	..	..	123,212	122,812	..	..	..	8	..
Chutouchi	176	1	171,722	250,533	4	2	6	5	..
Wildcats	..	..	..	..	..	..	..	..	7
Total	13,046	36	921,693	981,320	7	27	34	31	7

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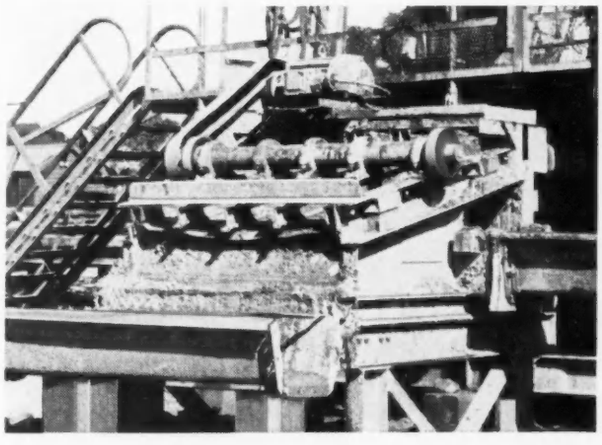

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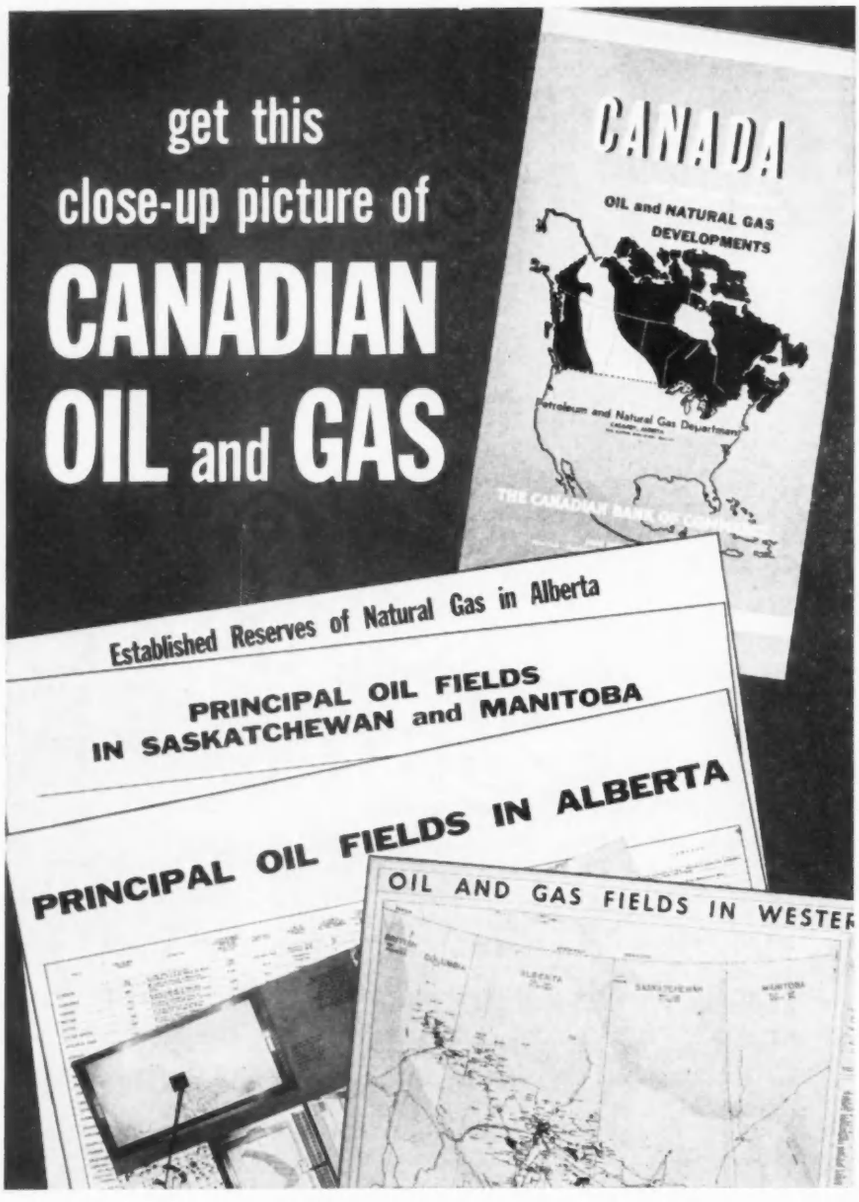

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Japan . . . oil and gas production at new highs

JAPAN'S OIL INDUSTRY continued to expand in 1959 and 1960. Crude oil and natural gas production reached new heights. Exploration, particularly offshore, made important strides. Secondary recovery efforts, particularly in Yabase oil field, Japan's largest, are paying off. Greater emphasis is being placed on drilling for and production of natural gas, despite a surface submergence problem being encountered, particularly in the Niigata gas fields.

Production. Crude oil production amounted to 2,856,149 barrels last year, an average of 7,825 barrels per day (Table 1). This was 9.3 percent above the 7,160 bpd of 1958. Yabase field's production, 5,939 bpd in 1959,

TABLE 1—Crude Oil Production in Japan in 1959, by Districts and Companies

PREFECTURE OR DISTRICT and Main Oil Fields			
Teikoku Oil Co. and Others	JAPEX	Total Barrels	Barrels Daily
AKITA:			
Yabase	Sarukawa, Tsuchizaki offshore	2,167,692	5,939
NIIGATA:			
Niitsu, Nishijima, Higashizawa, Kuroi, Kubiki	Tamugiyama, Mitsuke	494,731	1,355
YAMAGATA:			
Innai, Shonai	Fukura	152,981	419
HOKKAIDO:			
Ishikari, Azuma	Barato, Biratori	40,519	111
OTHERS:		226	1
Total		2,856,149	7,825

TABLE 2—Natural Gas Production in Japan in 1959, by Districts and Companies

PREFECTURE OR DISTRICT and Main Gas Fields		Thousand Cubic Feet	
Teikoku Oil Co. and Others	JAPEX	1959	1958
NIIGATA			
Niigata, Uchino, Aga, Nagaoka	Higashi-Niigata, Mitsuke	10,334,864	8,212,645
CHIBA			
Otaki, Mohara, Kanto		3,546,862	2,182,961
AKITA			
Yabase		3,272,217	2,012,284
OTHERS		665,229	583,898
TOTAL		17,819,172	12,991,788
Daily		48,820	35,594

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comprised 75.9 percent of Japan's oil production last year. Teikoku Oil Company operates most of this production and hence continues to lead other Japanese oil producers. A small amount of natural gasoline (12,636 barrels) is included in the 1959 crude production total.

Natural gas production in 1959 (Table 2) amounted to 17,819 MMcf, an average of almost 49 million cubic feet daily. This was 37.2 percent over 1958 output, which was larger than originally reported.

A notable trend is the increase in production of natural gas without a high water content typical of the majority of such production in Japan. Some new gas-bearing structures provide relatively dry gas. About 30.7 percent of the 1959 yield was dry gas, compared to 23.6 percent in 1958.

Withdrawal of gas and water is apparently causing a land submergence problem in Niigata, similar to the difficulty caused by oil production at Long Beach, Calif.

TABLE 3—Drilling Activity and Producing Wells in Japan in 1959

Tests	Wells Completed			Footage Drilled			Wells in Progress at End of Year			Status of Wells at End of Year				
	Producer	Dry	Total	Exploration	Exploitation	Total	Drilling	Testing	Total	Fields	Producer	*Sec.-Recov.	†Shut In	Total
Oil	87	56	143	301,817	289,481	591,298	23	5	28	Oil	3,103	49	598	3,750
Gas	158	16	174	133,102	436,373	569,475	19	7	26	Gas	1,023	42	333	1,398
Total	245	72	317	434,919	725,854	1,160,773	42	12	54	Total	4 126	91	931	5,148

*Secondary recovery wells. †Or suspended.

Drilling. There were 317 wells completed in Japan last year, and hole drilled exceeded a million feet (Table 3). Completions included 87 oil wells,

158 gas wells, and 72 dry holes. Footage for exploration slightly exceeded that for development. These figures emphasize the magnitude and favorable success ratio of recent exploratory drilling in Japan, and also the increased stress on drilling for gas. The 1959 footage of 1,160,773 was 21.6 percent over the 954,742 feet of 1958.

There were 42 wells drilling at the end of 1959 and 12 testing. Bad weather caused withdrawal to Tsuchizaki harbor of the three-legged offshore drilling platform "Hakuryu" operated by Japan Petroleum Exploration Company, Ltd. (JAPEX),

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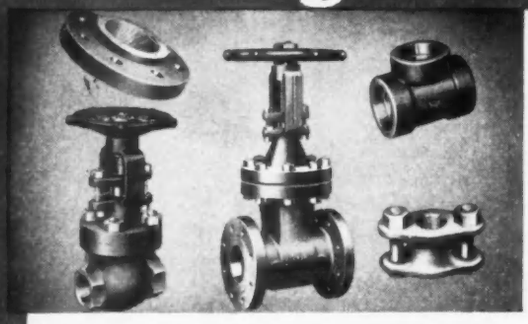

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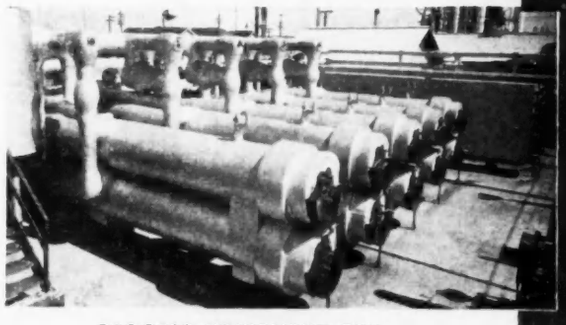

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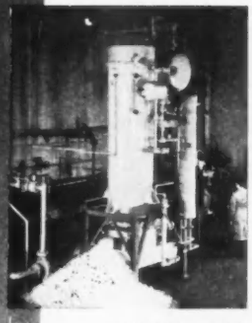

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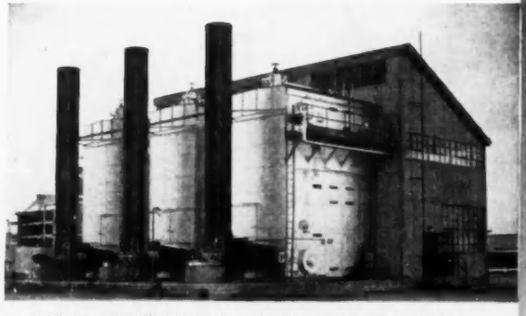

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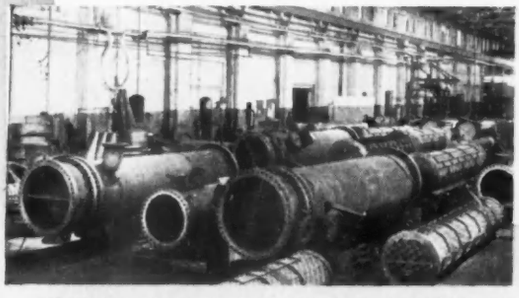

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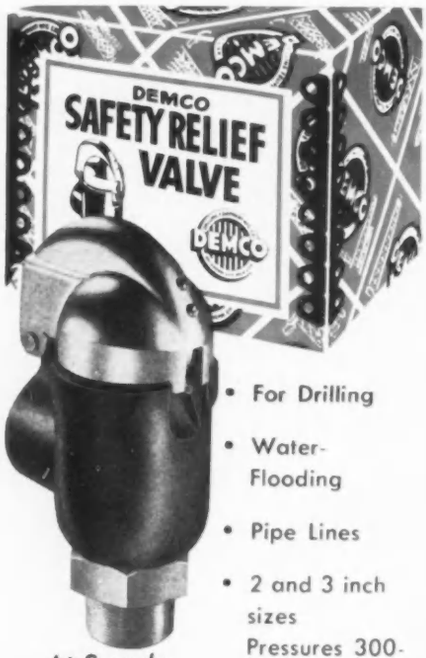

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JAPAN

early in 1960. However, operations were to be renewed, encouraged by successful exploration offshore from Yamagata and Niigata prefectures in the Sea of Japan.

Exploration. In addition to the offshore success reported last year (WORLD OIL, August 15, 1959, page 265), a new producing horizon was found at Shizukawa SK 1 location off Tsuchizaki at a depth of 4,768 feet. An oil production test of 377 barrels daily was recorded on a 6-mm (about ¼-inch) choke.

JAPEX also reported a number of other discoveries in 1959. On Hokkaido, Barato SK9 was completed flowing 40 barrels daily on a 3.2-mm (about ⅛-inch) choke. In Akita, Sarukawa SK3 was completed as a small oil discovery, and was followed by five more successful oil wells. The highest initial potential of the group was well SK8, completed for 161 barrels of oil daily on 2.5-mm bean from an 88-foot producing interval. Total depth of this well was 2,391 feet.

In Yamagata, Amarume SK1 was completed for 135 barrels daily through 6-mm bean from a 36-foot interval. Total depth was 3,990 feet. Three moderate-size gas discoveries were reported at Higashiniigata SK1, and at Mitsuke SK8 and SK9. The Higashiniigata well bottomed at 10,020 feet, the two others slightly below 6,000 feet.

Geophysical exploration in Japan last year amounted to 107 party-months. Included were 69 crew-months of seismic work (58 contract and 11 company crew-months); 34 party-months of gravity work, including 25 contract and 9 company; and 4 (contract) crew-months of other geophysical surveys. These geophysical data are according to a report to to be published in *Geophysics*. Vol. 25, No. 6.

Investment. JAPEX recently acquired $7 million in new financing, including about $5 million budgeted by the Japanese government, the remainder being privately acquired. Teikoku Oil Company is privately owned and financed.

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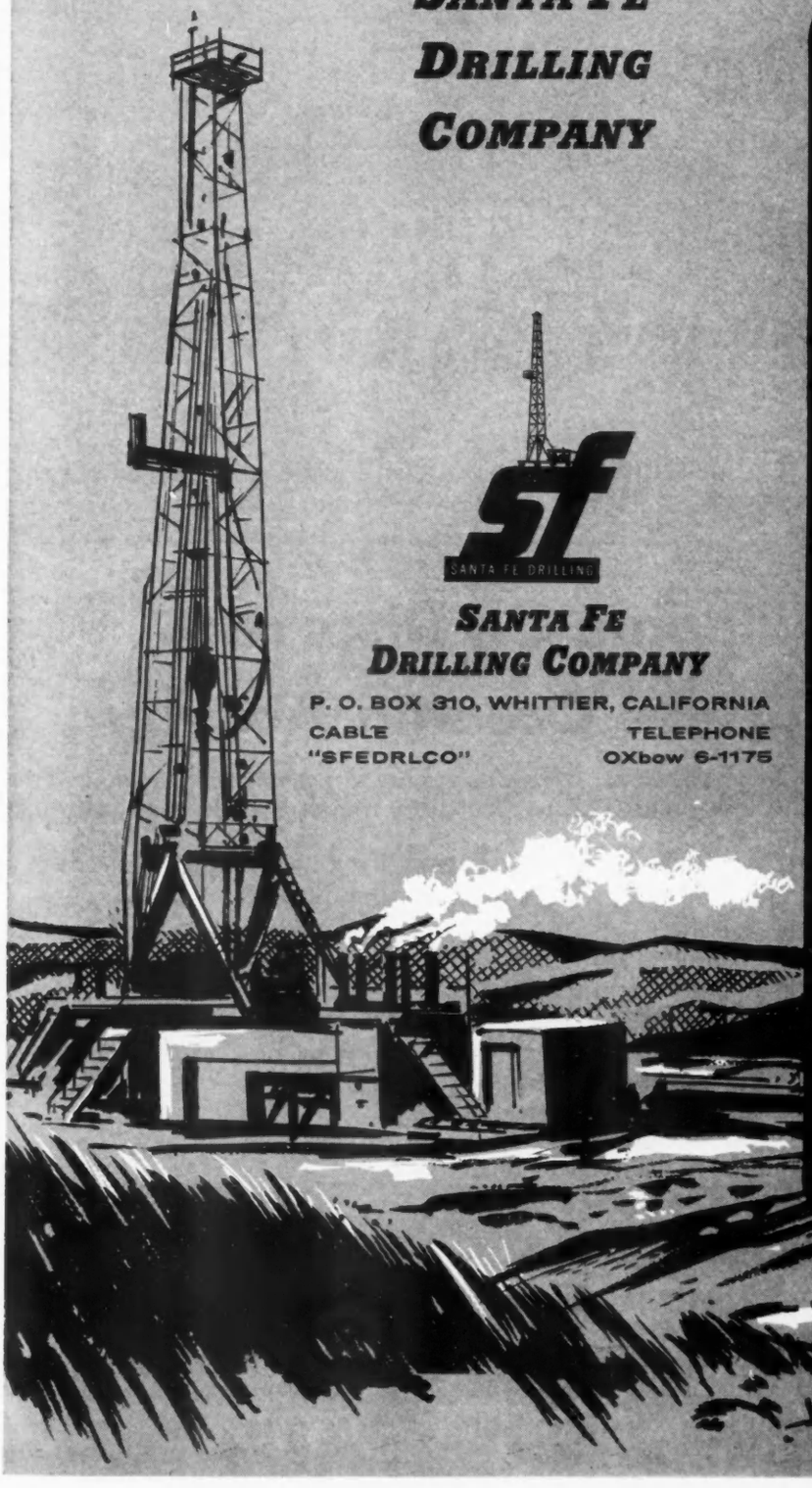

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Philippine Oil Discovery Features Oceania Activity

Cebu Island find provides missing link in producing chain between Java and Japan

COMMERCIAL OIL production was established in the Philippines when Redeco Reina Regente 1A on Cebu Island was drilled to 1,335 feet in August 1959 and was completed for 72 barrels daily. Thus a missing link in the producing chain between Java, Sumatra and Borneo to the south and Taiwan, Japan, and Sakhalin to the north was filled. Exploratory activity in the Philippines rose to new heights.

Renewed efforts were being made to find domestic sources in oil-hungry Australia. The search continued also in Papua, Timor, West New Guinea, and offshore in British Borneo.

Since all producer groups in Indonesia registered increases in 1959, the region's crude output rose. New discoveries by Royal Dutch Shell group members and by Caltex in Sumatra improved the outlook somewhat, but hydraulic fracturing in old fields was credited with much of the production boost.

Commercial production started anew in north Sumatra in 1959. The Indonesian outlook remained cloudy, since the only future opportunities for new private groups there appeared to lie in Argentine-type production contracts.

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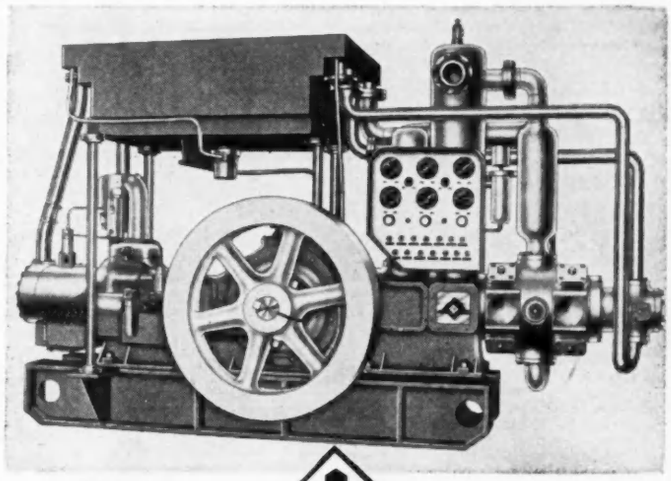

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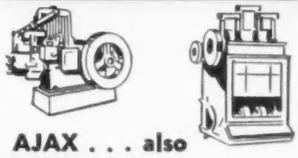

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Indonesia . . . production is up but political picture gloomy

OIL OUTPUT was boosted in Indonesia by all producing groups last year. Helped largely by hydraulic fracturing, the older producing fields operated by Royal Dutch Shell member companies and Standard-Vacuum Petroleum Mij were yielding increased quantities of crude.

Despite the statistical gains, the political situation still clouds Indonesia's oil future, as each new draft of a proposed oil law being considered seems more heavily weighted against private enterprise. Indonesia is interested in contract-type relationships with private firms (similar to Argentina's). Evidently there will be no new concessions.

Legal proposals. Laws similar to the draft previously discussed in WORLD OIL (August 15, 1959, page 271) are still being considered. A new petroleum law draft was submitted to parliament on January 5, 1960, supplanting the March 1959 submittal. New concession rights would be restricted to government entities. Operations by private firms would be pursuant to contracts with the government.

Japanese agreement. Permina, the Indonesian government agency, has handled rehabilitation of the north Sumatra oil fields since the government officially renounced Royal Dutch Shell's pre-war concessions there in 1958. Work has been concentrated in Rantau field, where Shell drilled 125 wells prior to 1941. About one-fourth of north Sumatra's pro-

TABLE 1—Crude Oil Production, Producing Wells, and Driling in Indonesia in 1959, by Companies

COMPANY	CRUDE OIL PRODUCTION					Producing Oil Wells End 1959	WELLS COMPLETED IN 1959				
	Total Barrels		Barrels Daily				Wells				Total Footage
	1959	1958	1959	1958	% Diff.		Oil	Gas	Dry	Total	
Caltex Pacific Oil Company	60,470,994	54,454,241	165,674	149,190	11.0	268	41			41	35,937
Royal Dutch Shell group members	43,169,060	36,734,830	118,271	100,643	17.5	1,424	50	1	10	61	305,214
Standard-Vacuum Petroleum Mij	30,093,137	27,432,264	82,447	75,157	7.3	467	22		18	40	79,252
Permina	3,520,000*	365,000*	9,644	1,000*	864.4	†	†	†	†	†	†
Total Indonesia	137,253,191	118,986,335	376,036	325,990	15.4	2,159	113	1	28	142	420,403

*Estimated †Not available.

TABLE 2—Royal Dutch Shell's Crude Oil Production, Producing Wells, and Development Drilling in Indonesia in 1959, by Fields and Companies

Field and Location	Company	Year Discovered	CRUDE OIL PRODUCTION			Producing Wells End 1959	WELLS COMPLETED IN 1959					Wells Drilling End of 1959
			Total Barrels in 1959	Barrels Daily Year 1959	Barrels Daily Dec. 1959		Wells				Total Footage (Feet)	
							Oil	Gas	Dry	Total		
JAVA												
Kawengan	N.V. de B.P.M. (Shell)	1926	1,577,230	4,321	3,818	79[1]						
Kruka	N.V. de B.P.M. (Shell)	1929	711,050	469	443	51						
KALIMANTAN												
Anggana-Muara	N.V. de B.P.M. (Shell)	1902	479,630	1,314	1,205	84[2]						
Balik Papan	N.V. de B.P.M. (Shell)	1903	1,970	5	—							
Bunju	Permindo	1930	3,834,260	10,505	9,995	41						
Sambodja	N.V. de B.P.M. (Shell)	1910	299,660	821	781	48						
Sanga Sanga	N.V. de B.P.M. (Shell)	1897	875,270	2,398	2,345	89[4]						
Tandjung[3]	N.V. de B.P.M. (Shell)	1938	85,890[5]	235	142		4		1	5	20,231	
Tarakan	N.V. de B.P.M. (Shell)	1906	1,095,410	3,001	3,043	388						
SOUTH SUMATRA												
Babat	N.V. de B.P.M. (Shell)	1901	13,510	37	38	14						
Badjubang	Permindo	1927	596,230	1,634	1,569	31						
Gunung Kemala	N.V. de B.P.M. (Shell)	1938	887,350	2,431	2,134	15						
Keban	N.V. de B.P.M. (Shell)	1941	43,710	120	164	2						
Kenali Asam	Permindo	1931	3,860,760	10,577	11,194	130	19			19	[6]	1
Limau	N.V. de B.P.M. (Shell)	1928	15,575,780	42,673	47,213	103	17	1	2	20	[7]	
Mangundjaja	N.V. de B.P.M. (Shell)	1935	501,490	1,374	1,499	45			1	1		
Meruo Senami	Permindo	1938	28,180	77	72	3						
Prabumulih West	N.V. de B.P.M. (Shell)	1953	731,240	2,003	1,261	10	1			1	[7]	
Sei Taham	N.V. de B.P.M. (Shell)	1903	51,310	141	116	5						
Setiti	Permindo	1936	421,030	1,154	843	15			1	1	[6]	
Suban Djerigi	N.V. de B.P.M. (Shell)	1905	196,540	538	492	17						
Sungel Gelam	Permindo	1958	28,820	79	64	3						
Talang Djimar	N.V. de B.P.M. (Shell)	1937	5,659,900	15,507	13,246	107					[7]	
Tandjung Tiga	N.V. de B.P.M. (Shell)	1940	2,985,780	8,180	8,725	39	4		1	5	[7]	1
Tempino	Permindo	1931	2,953,960	8,093	7,241	111	1			1	[6]	1
West Tandjung Miring	N.V. de B.P.M. (Shell)	1938	213,100	584	971	4	2			2	[7]	
Total, Royal Dutch Shell Group in Indonesia			43,169,060	118,271	118,614	1,434[8]	48	1	6	55	273,422 [6, 7, 9]	3

[1] Includes 2 gas wells. [2] Includes 3 gas wells. [3] Field shut in, pipe line outlet not yet available. [4] Includes 5 gas wells. [5] Production for own use. [6] Total development drilling by Permindo in South Sumatra fields amounted to 126,831 feet. [7] Total development drilling by B.P.M. in South Sumatra fields amounted to 146,591 feet. [8] Includes 1,424 oil wells and 10 gas wells. [9] Excludes 31,792 feet of exploratory drilling by Royal Dutch Shell companies.

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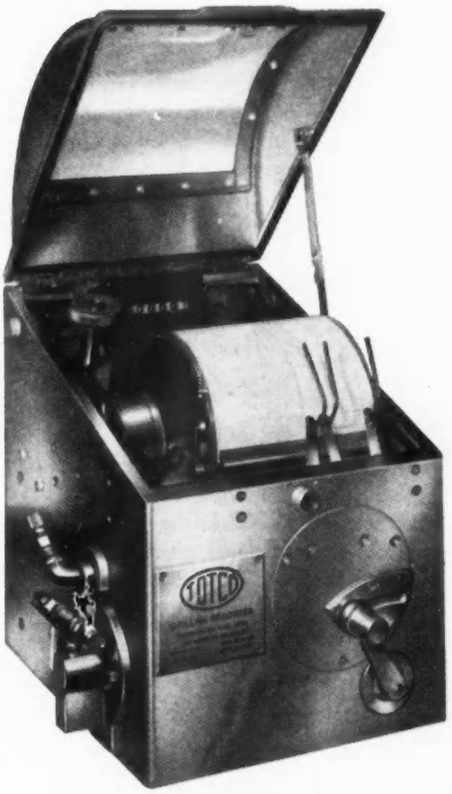

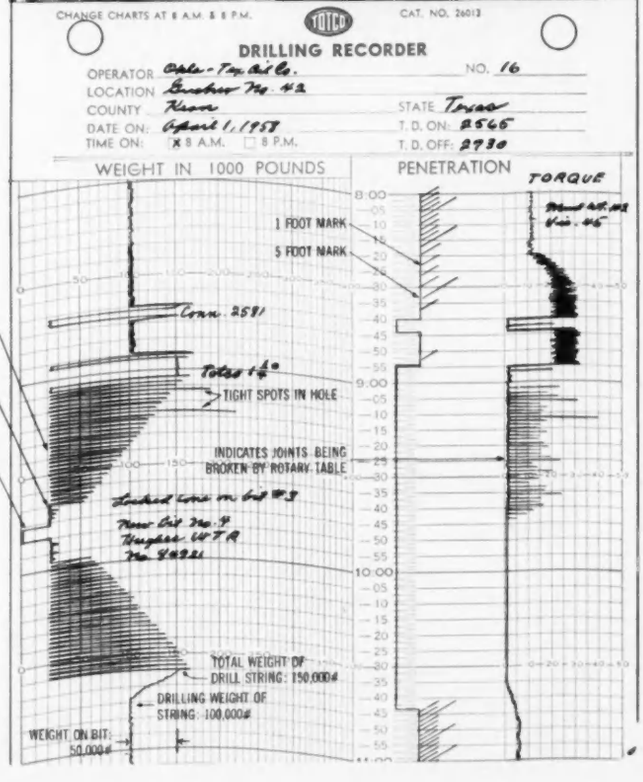

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INDONESIA

ductive capacity had been restored by the end of 1959, when production had reached 12,600 barrels daily.

North Sumatra Oil Development Cooperation Co., Ltd., is the Japanese group obligated by an agreement ratified in April 1960, to raise production in north Sumatra to about 41,000 barrels daily within 10 years. Japanese financiers have agreed to invest $52 million, which is to be returned in kind as a percentage of crude produced.

The Brandan refinery has been partially rehabilitated also, and was capable of charging about 2,200 barrels of crude daily in early 1960 for domestic consumption. Most of the north Sumatra crude output has been shipped to Japan since mid-1959. Of the estimated 1959 average production (9,644 barrels daily), about 7,500 bpd was sent to Japan.

Royal Dutch Shell. Production was boosted to 118,271 barrels of crude daily in 1959, as shown in Table 1 and detailed in Table 2. The increase was 17.5 percent above 1958's 100,643 bpd. The two Shell companies, B.P.M. and Permindo, produced oil from a total of 26 fields last year, including 2 in Java, 7 in Kalimantan (Indonesia Borneo) and 17 in south Sumatra. At the end of 1959, the Shell companies had on production 220 flowing oil wells and 1,204 on artificial lift. Ten gas wells were produced also.

Drilling was active, with 55 development wells aggregating 273,422 feet of hole and 6 wildcats with a total footage of 31,792 being completed in 1959. Two wildcats struck oil. Bentajan 4 in south Sumatra, drilled to 5,991 feet, was completed in Miocene-Oligocene pays at 3,806 feet for 377 barrels of oil daily. Kambitin 2 in east Kalimantan, drilled to 4,971 feet, was completed for 333 barrels daily from an Eocene zone at 3,086 feet.

Work was under way on the 160-mile, 20-inch crude oil pipe line from Tandjung field in Kalimantan to the Balik Papan refinery.

B.P.M. was operating four of its Indonesian refineries, charging about 145,100 barrels daily at the end of 1959.

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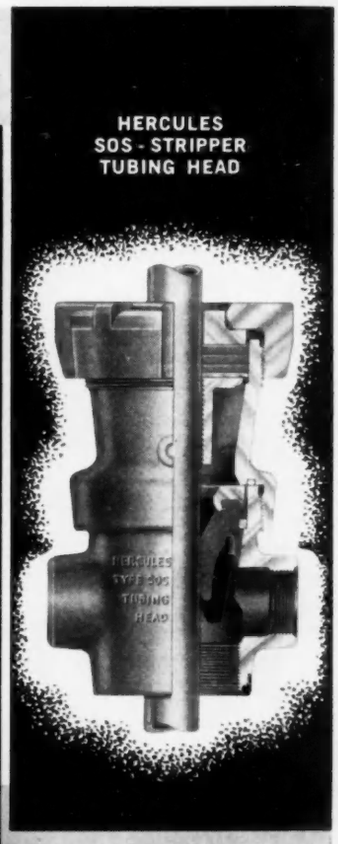

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from the newer central Sumatra oil fields at Minas and Duri. Production last year averaged 165,674 barrels daily (Table 1), representing an 11 percent increase above 1958. Caltex had 34 flowing oil wells, 234 on pump, and 77 shut in at the end of December. Production continued to rise in 1960. A total of 28,395,317 barrels was produced through May 31, 1960, an average of 186,811 barrels a day. The most productive month during this period was April, when an average of 212,536 barrels was yielded by Caltex's fields.

Drilling by Caltex was diminished somewhat last year, with 41 completions and 35,937 feet of hole comparing with 81 completions and 61,500 feet in 1958. Fewer completions are being made in the shallow (800 feet) Duri field. About 200 wells have been completed at Duri and about 160 at Minas. Early in 1960, Minas field was producing about 160,000 barrels daily, and Duri field about 35,000.

Caltex's only wildcat completed last year, at Pematang, a few miles southwest of Bekasap, resulted in an oil discovery. This well was drilled to 6,500 feet. At least two oil zones were proven. Tests of the interval 4,835-4,974 feet yielded a peculiar, highly viscous type of crude, composed almost wholly of paraffin and aromatics. The main pay is shallower, at 2,780 feet, where about 35° API gravity high-pour-point crude was tested from Miocene beds. The discovery had yet to be evaluated in mid-1960.

Caltex has been operating with two seismic crews in central Sumatra during the past 18 months, but expected to release one of them late in 1960.

Stanvac. Crude oil output continued to rise in Stanvac's south and central Sumatra concessions. The 82,447 barrels daily last year was 7.3 percent above the 75,157 bpd of 1958. The majority of the wells were on gas lift. Stanvac reported 467 oil wells producing at the end of 1959 and 334 shut in.

Stanvac completed 29 development wells (21 oil wells and 8 dry holes) in 1959, aggregating 53,534 feet of hole. Three wells were being drilled at year end. Wildcatting was active, with 11 tests completed, including one oil well brought in. This work amounted to 25,718 feet of exploratory hole.

Emphasis of Stanvac's new drilling program in central Sumatra, which dates to July 1959, is on shallow drilling. Ukui 57, the first completion, came in at 1,680 barrels daily. After 5 ensuing dry holes, Ukui 62 was completed as a producer in the Lirik sand. Lirik 90, a stepout well, was also successfully completed.

Stanvac's Sungei Gerong refinery continued to operate at near capacity thruput last year, charging an average of 77,200 barrels of crude daily.

The urea fertilizer plant to be built by the Indonesian government near Palembang in south Sumatra, utilizing gas from Stanvac's Radja field, has been authorized and was reported under construction in 1960. Foster Wheeler Corp. is doing construction and engineering work.

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British Borneo . . . crude oil production increases 3 percent, exploratory drilling up

SOME INCREASE in activity was indicated in British Borneo in 1959. Crude oil production increased by 3 percent to 40,071,902 barrels (109,786 daily) in 1959, compared with 106,632 bpd in 1958. Increases in crude yield from Seria and Jerudong fields offset the continuing decline at Miri.

Brunei Shell Petroleum Company Ltd. established a new record producing depth at Seria, where productive intervals vary from 834 to 10,201 feet. Deepest recorded producing horizon at the end of 1958 was 8,994 feet. Exploratory drilling was also increased slightly in 1959.

Production. Seria field in Brunei yielded 108,399 bpd for a total of 39,565,614 barrels in 1959. This represents 98.7 percent of the British Borneo total. The 1958 daily average at Seria was 105,448 barrels. Two flowing wells at Jerudong in Brunei averaged 304 barrels daily last year. Sarawak Shell Oilfields Ltd.'s production at Miri field, British Borneo's oldest, averaged 1,083 barrels daily in 1959.

Drilling. Development drilling in North Borneo last year was restricted to Seria field where 20 oil wells and 2 dry holes were completed. Total development footage was 121,236 feet.

Exploration. Each of the three Royal Dutch Shell group companies operating in North Borneo drilled one wildcat during the year. Brunei Shell drilled Binturan 1 to 11,110 feet. Shell Company of North Borneo Ltd. drilled Mengalum 1 to 6,997 feet; and Sarawak Shell drilled Engkabang 1 to 10, 854 feet at the end of 1959. The total footage figure for 1959 was thus 150,197. Following the arrival in late 1959 of the new Brunei Shell mobile drilling platform "Orient Explorer," capable of deep drilling in 125 feet of water, much prospective submerged acreage in the South China Sea was to be evaluated.

Refining. The Lutong refinery, operated by Sarawak Shell, continued to run at capacity at the end of 1959, charging 47,000 barrels of crude daily.

Crude Oil Production, Producing Wells, and Development Drilling in British Borneo in 1959

Country	Brunei	Brunei	Sarawak	Total British Borneo
Company	Brunei Shell Petroleum Company Limited	Brunei Shell Petroleum Company Limited	Sarawak Shell Oilfields Limited	
Field (or producing area)	Seria	Jerudong	Miri	
Year of discovery	1929	1955	1911	
Footage drilled in 1959, feet	121,236			121,236
Wells completed in 1959	22			22
a. Oil wells	20			20
b. Gas wells				
c. Dry holes	2			2
d. Suspended				
e. Water injection wells				
Wells actually drilling at end of 1959	2[1]			2
Drilling wells suspended at end of 1959	3		5	8
Total producing wells at end of 1959	325	2	175	502
Flowing wells	113	2		115
Pumping wells	30		175	205
Other artificial lift wells	182			182
Total wells drilled to end of 1959	523	9	618[2]	1,150
Producing depths at end of 1959, feet	834-10,201	3,523-4,021	300-6,270	
Crude oil production in 1959, barrels	39,565,614	110,875	395,413	40,071,902
Crude oil production in Dec. 1959, bbls. daily	99,367	382	1,151	100,900
Cumulative crude oil production to end of 1959, barrels	485,186,307[3]	409,806	75,509,837[3]	561,105,950[3]
Base of crude	Mixed	Mixed	Mixed	
API gravity of crude	10-48°	40-42°	17-46°	
Age of producing formation	Tertiary	Tertiary	Tertiary	
Kind of producing formation	Sands	Sands	Sands	

[1] Includes Seria 203 (deepening). [2] Includes 9 twin wells. [3] Includes estimated oil produced during Japanese occupation.

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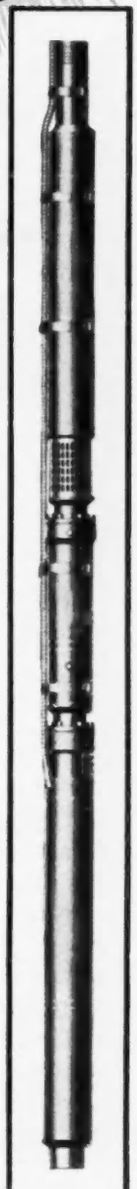

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Philippines . . .

important find on Cebu

PHILIPPINE oil exploration in 1959 was highlighted by the nation's first oil discovery. Made by Republic Resources and Development Co. on Cebu Island, the strike was of major importance, regionally. It confirmed that conditions favorable for oil accumulation exist in the archipelago.

This first commercial discovery, Reina Regente 1-A, was drilled to 1,335 feet in August, and production tests indicated a productive capacity of 72 barrels daily of 41-45 gravity paraffin-base crude.

Surface casing of Reina Regente 1-A-X, located about 35 feet east of the discovery well, was set on October 3. On Christmas Eve, a depth of 6,015 feet had been reached, and production tests indicated production of 100 barrels daily from a new zone. Crude from both wells is being trucked to an 80,000-barrel storage tank pending shipment to the Caltex refinery at Bauan, Batangas.

REDECO continued with a development drilling program for the central Cebu area. Early in 1960 it drilled Villalon 1, a dry hole, about 2,900 feet northwest of the producing wells. Mercado 1, located 1,950 feet south-southeast of the producing wells, was abandoned at 1,994 feet.

Three other 1960 tests by REDECO follow:

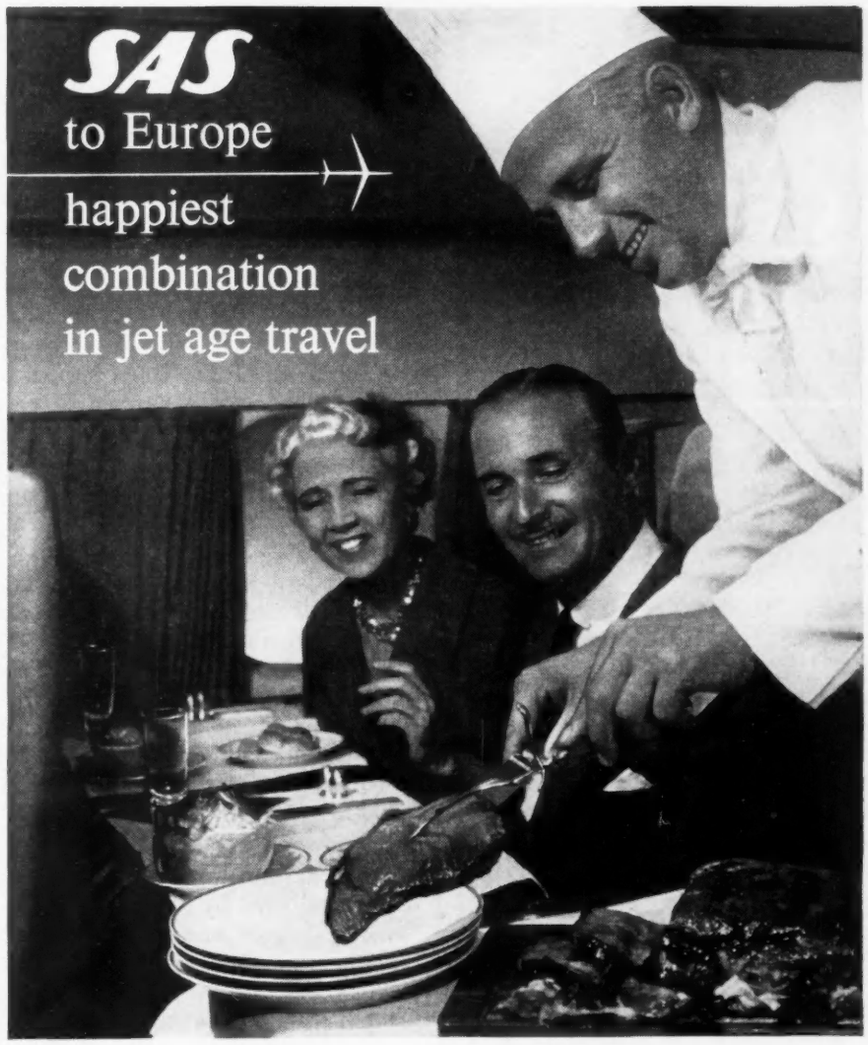
1. Reina Regente 2-A, 910 feet from the two oil producers, was spudded April 19, and at midyear it was at 2,601 feet, awaiting perforations of several zones prior to production tests.

2. Reina Regente 3-A, 975 feet south of the 1-A discovery well, spudded May 25, was abandoned at 1,864 feet at midyear, when the company considered it inadvisable to drill deeper with the rig being used.

3. Alegria 1, located in a concession bordering the Spanish land grant where the discovery wells were drilled, ran into difficulties at 5,370 feet at midyear. REDECO is the operator of this well, in which Philippine Oil Development Co. holds an equal share.

Exploration. Other companies engaged in oil searches include the following:

• Anglo-Philippine Corp. this year shifted its core hole activity to



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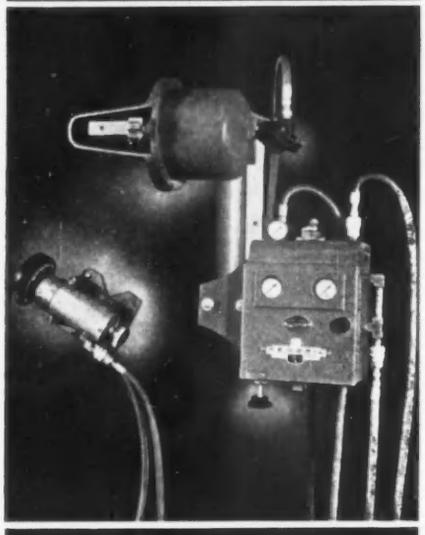

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PHILIPPINES

Negros, where it currently is in progress. The company during the last quarter of 1959 drilled three 1,500-foot core holes, two on Mindoro Island and one on Caluya Island.

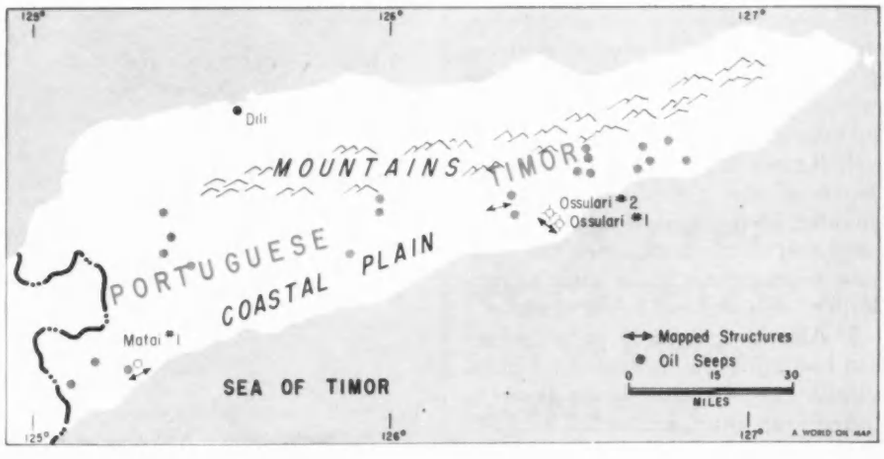
• Maremco Mineral Corp. conducted gravity work in 1959 and 1960 in the Cagayan Basin, Negros and Cotabato Basin, western Mindanao.

• White Eagle Oil Corp. last year began a shallow stratigraphic test program, which resulted in oil and gas shows in every test. A similar program was scheduled to be carried out in Camotes Island and Bondoc Peninsula.

• Standard Vacuum Oil Co. last year drilled three dry holes within a radius of three miles of its 1958 Cagayan Basin gas discovery, Ipil 1. In 1960, Stanvac abandoned Rizal 1 in the Cagayan Basin at 9,236 feet, due to technical difficulties and on June 9, spudded in Narra 1, a projected 5,000-foot test about 10 miles east of Ipil 1.

Exploration operations also were being conducted by Philex Oil Development, Inc.; American Asiatic Oil Corp.; Acoje Oil Exploration and Drilling Co., whose 10,000-foot test being drilled with Hixbar Mining Co. had reached 7,232 feet at June 8, with 20 oil and gas shows reported; Philippine Oil Development Co., Inc.; Pacifica, Inc., and San Jose Oil Co., Inc.

The first commercial oil production of the Philippines was discovered in 1959 on Cebu Island by REDECO's Reina Regente 1-A. The discovery well, below center of map, yielded 72 barrels daily from 1,335 feet. In 1958 Stanvac discovered gas in the Cagayan Basin, northern Luzon Island, in Ipil 1, top of map.



Timor . . . exploratory work continues

TIMOR OIL, LTD. and Tradewinds Exploration, Inc., continued their exploration program during mid-1960 in Portuguese Timor along the southeastern coastal strip of the island. The drilling program was to be renewed at the close of the monsoon season at mid-year.

Two wells were completed last year. Ossulari 1, located on an anticline 5 miles inland, and 12 miles east-southeast of Aliambata was drilled to 6,755

feet. At this depth the hole was junked due to mechanical difficulties. The next test, Ossulari 2, located 2 miles northwest of Ossulari 1, was dry at 4,600 feet (total depth).

A third drill site had been chosen by mid-1960. The Matai structure, 75 miles southwest of Ossulari, is to be tested. There are three high-gravity oil seeps on this structure, yielding about 12 barrels daily. A 5,000-foot test through Tertiary sands to the Mota Bui limestone (Triassic) was planned. More than 8,500 feet of core drilling has been done in the Matai vicinity.

Additional gravity work was completed, supplementing coverage reported last year (WORLD OIL, August 15, 1960, Page 283).

West New Guinea . . . big cutback

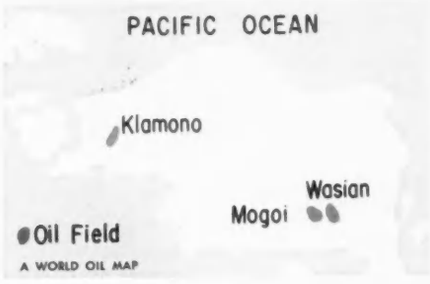
EXPLORATION WORK in West New Guinea was being severely curtailed as of mid-1960. N V Nederlandsche Nieuw Guinee Petroleum Mij (NNGPM) is continuing limited exploration near producing fields in the Vogelkop Peninsula, but the oil search elsewhere in this territory was stopped.

The three oil fields, Klamano, located in the Salawati Basin, and Wasian and Mogoi, east of the Ajamaroe plateau in the Bintoeni Basin, continued to decline toward depletion. NNGPM is trying to recoup as much as possible of the heavy deficit incurred during the 25-year oil search before these fields are exhausted.

Crude oil production amounted to 1,660,904 barrels in 1959, an average of 4,550 barrels daily. This was a 10.9 percent decline from 5,105 bpd of 1958. Daily production figures in 1959 by fields were 4,042 barrels from Klamono; 301 from Wasian; and 207 from Mogoi. All declined compared to 1958. Klamono produces heavy asphaltic crude and Wasian and Mogoi yield light paraffinic types.

Hence, NNGPM, which is composed of Royal Dutch Shell, Stanvac and Caltex interests on a 40-40-20 percentage basis respectively, relinquished most of its 100,000-square-mile concession, including all acreage outside of Vogelkop, as of April 15, 1960.

Oil Fields of the Vogelkop (Bird's Head) Peninsula, West New Guinea

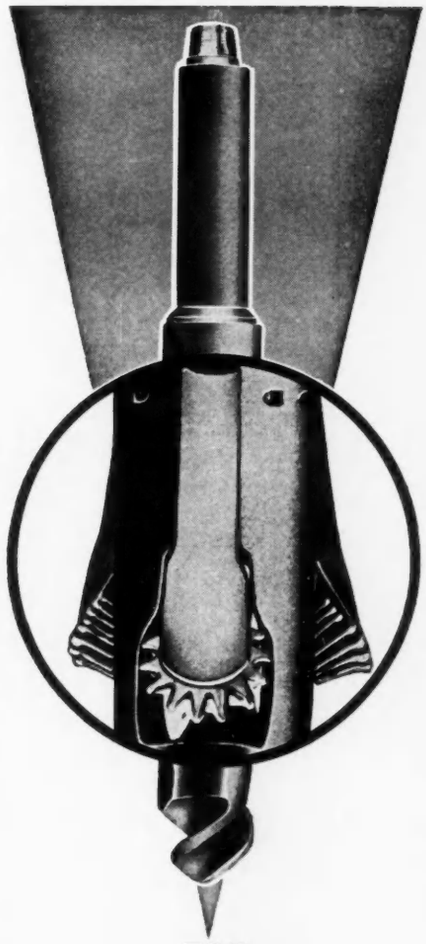


Drilling. Four dry wildcat wells were completed in 1959, including Jaosokor 1, which was drilling below 1,400 at the start of the year. Together with 495 feet of development drilling at Klamono last year, the 18,168 feet of exploratory drilling provided a total of 18,663 feet of hole cut in West New Guinea in 1959. Although this footage is about the same as that of 1958, an abrupt drop is expected in 1960.

Production and Drilling in West New Guinea in 1959, by Fields

All development is by one company, N. V. Nederland Nieuw Guinee Petroleum Mij (MNGPM).

ITEM	Klamono	Wasian	Mogoi	Total
Year of discovery	1936	1940	1940	
Development footage drilling in 1959	495			495
Oil wells drilled in 1959				
Total wells drilled to end of 1959	41	23	56	120
Total producing wells at end of 1959	25	6	14	45
Flowing wells		1		1
Pumping wells	25	5	14	44
Producing depths in feet	300	2,900-3,225	1,250	
Gross barrels clean crude production in 1959	1,475,300	109,953	75,651	1,660,904
Daily average production in Dec. 1959, bbls	3,714	261	174	4,149
Cumulative production to end of 1959, barrels	18,901,157	1,611,500	4,265,768	24,778,425
Base of crude	Asphaltic	Paraffinic	Paraffinic	
API gravity of crude	18.8	41.9	42.8	
Age of producing formation	Miocene	Miocene	Miocene	
Type of producing formation	limestone	limestone	limestone	
Structure of controlling production	Anticline	Anticline	Anticline	



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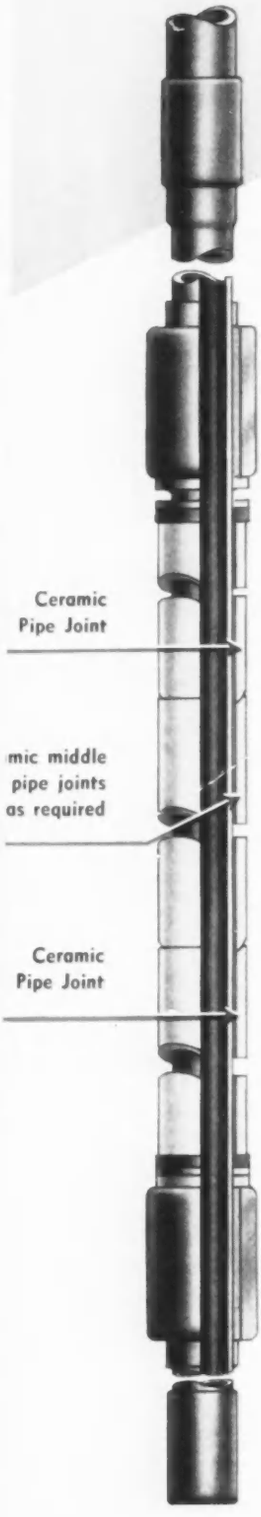

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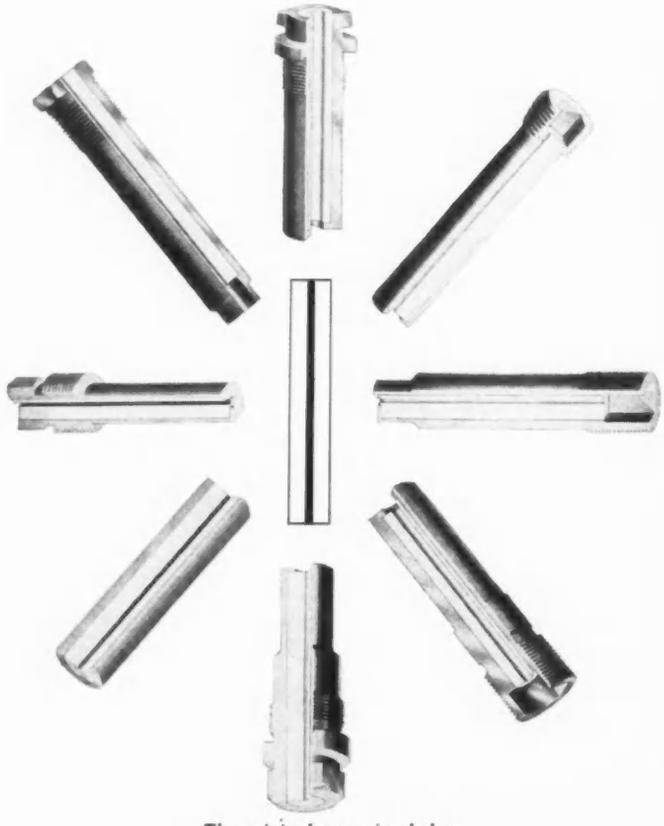

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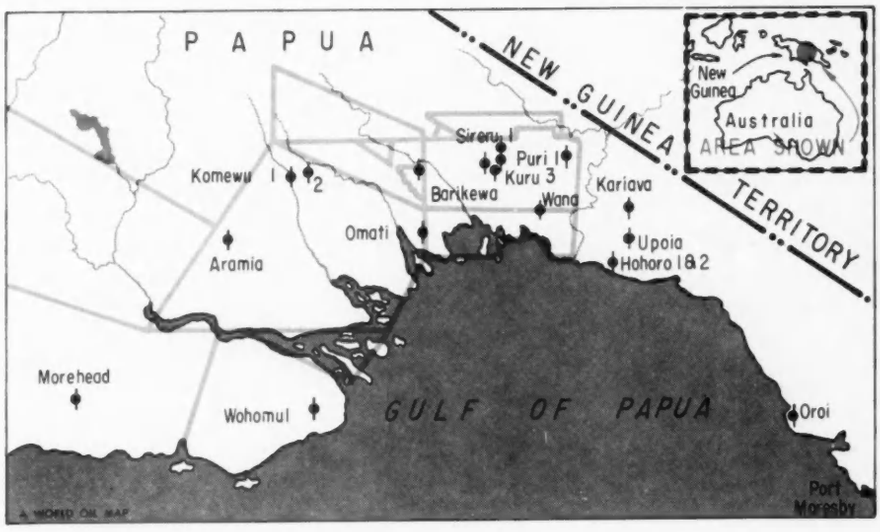
Concessions and Drilling Activity in Papua

(An Australian territory on the island of New Guinea)



Papua . . . wildcatting continues despite hardships

WILDCATTING continued in Papua in mid-1960, despite the long history of disappointing results and the prodigious operating hardships in this remote jungle country. Australasian Petroleum Co. Pty., Ltd., was preparing to drill Iehi 1, located 15 miles northwest of Barikewa. BP Exploration Co. and Oil Search, Ltd., were partners in the Iehi venture, although Vacuum Oil Pty., Ltd., (Standard-Vacuum Oil Co. interests) declined to participate in this well.

A helicopter base was being completed near Barikewa to supply this operation, and a 2½-mile water line was laid from the Kikori River over pinnacled, creviced limestone terrain to the rig site. A detailed geological survey of the Kevi area, and geological reconnaissance of the Trans-Hegigio region were in progress in April 1960.

Australasian completed one well in 1959, Puri 1, which bottomed at 10,100 feet and tested a total of 3,500 barrels of crude oil before going completely to salt water. Bwata 1, located 15 miles northwest of Puri, was spudded August 4, 1959, and was drilling at the end of the year. Shows of dry gas were reported in two drill stem tests above 5,300 feet.

Testing was to be continued in the Puri area. The prospect was drilled on the basis of a surface structure, which proved to be thrust-faulted. Oil flowed from lower Tertiary limestones.

Tabulations of exploratory activity in Papua in 1959 are as follows: 3.1 party-months of seismic work; 1.6 crew-months geological work, and 10,100 feet of hole drilled.

Australia . . . oil, gas shows encouraging

PETROLEUM in commercial quantities has not yet been discovered in Australia. However, several interesting and encouraging shows of gas and oil have been found.

In the Australian territory of Papua on the island of New Guinea, north of the mainland, oil, gas, and condensate were discovered late in 1958 in Puri Well No. 1. Subsequent tests and the drilling of two deviated holes at the same location, Puri Wells No. 1A and No. 1B, indicated however that no commercial production was obtainable.

Although the results in Papua were disappointing, this discovery provided a stimulus to the search in the Territory, and further geophysical work and drilling are planned or in progress. (See details above.)

Well yields gas and condensate. At Port Campbell in the state of Vic-

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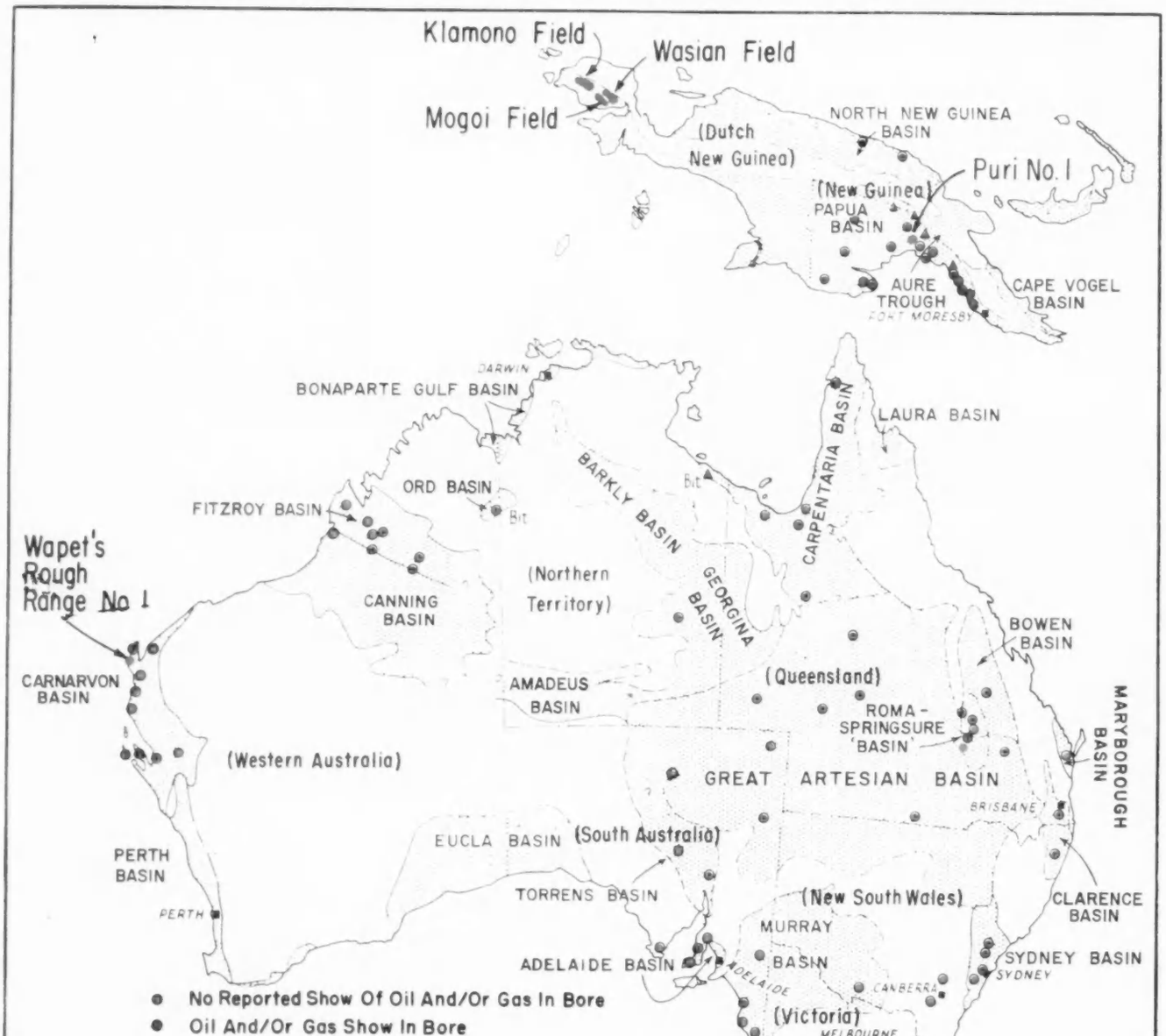
SEDIMENTARY BASINS AND OIL AND GAS OCCURRENCES IN AUSTRALIA AND NEW GUINEA



toria, gas in some quantity and some condensate were discovered in Port Campbell No. 1 well. However, subsequent testing indicated the presence of water in increasing quantities.

Port Campbell 1, about 100 miles west of Melbourne, was drilled by Frome Broken Hill Co. Pty. Ltd. It tested 20 barrels per day of distillate along with 4 million cubic feet of gas from a sand formation, of apparent Mesozoic age, at about 5,657 feet. Due to mechanical difficulties and water intrusion, the well was abandoned early in January 1960. It may have been on the edge of the main structure.

Frome Broken Hill Company in early July 1960 was preparing to drill Port Campbell 2. The structure is in the Portland-Mount Gambier portion of the large Murray River Basin, which centers around the common corner of the states of Victoria, South Australia, and New South Wales. The structure on which the Port Campbell wells are located apparently extends westward into South Australia.

TABLE 1—Summary of Drilling in 1959

STATE	Wells Completed, Abandoned, or Suspended		Wells Drilling, End of Year
	Wells	Footage	
Queensland	31	30,080	2
South Australia	1	12,637	..
Victoria	3	8,395	..
New South Wales	9	18,676	2
Western Australia	7	31,820	2
Northern Territory	1	2,458	..
Papua-New Guinea	2	17,402	..
Total	54	121,468	6

*** Combined total depths of wells completed or abandoned during 1959. In some of these wells, some of the footage actually was drilled prior to 1959. Footage drilled in 1960 not included.**

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AUSTRALIA

Queensland. Santos Ltd. and Delhi Australian Petroleum Ltd. planned to commence drilling in late August 1960 on a 6,000-foot test on Mornington Island in the Gulf of Carpentaria, Queensland. The Carpentaria Basin is an extension of the Great Artesian Basin.

Union Oil Co. of California, Kern County Land Co., and Australian Oil & Gas Corp. Ltd. expect to spud their first test of their extensive holdings by the end of October 1960. A 10,000-foot stratigraphic test tentatively has been located in the Surat Basin, Queensland, 150 miles southeast of Roma.

TABLE 2—Exploration Activity in Australia in 1959

STATE or TERRITORY	Nature of Survey and Duration in Party Months				
	Seismic	Gravity	Magnetic	Geological	Air-photo
Queensland	17.45	25.25	5	56.75	2
New South Wales		10	1	37	
Victoria		3.5		9.25	
South Australia	4	2		31.25	
Western Australia	12	7.5	3	43.25	1
Tasmania					
Northern Territory		5.5		39.75	
Papua-New Guinea	8	8.7		6.50	
Total, 1959	41.45	62.45	9	223.75	3
Total, 1958	56.75	29	5.5	139.25	

Subsidies. The Petroleum Search Subsidy Act 1957/58 continued to attract applications for subsidy for the drilling of stratigraphic wells in areas not previously investigated.

On November 4, 1959, the Petroleum Search Subsidy Act 1959 came into operation. This Act widens the scope of the original Act to include the grant of subsidy on approved geophysical and bore hole surveys and off-structure drilling. The response to this Act has been most encouraging, and indicates a continued upward trend in the tempo of exploration.

Drilling. Eleven wells drilled for oil or gas were completed in Australia during the first six months of 1960. It is estimated that about 10 more will be completed during the last six months, making a total of 21 expected to be completed in 1960.

Including structure holes, 54 wells were completed, abandoned, or suspended in 1959. (Tables 1 and 4.) Of these, 17 were over 2,000 feet deep. Combined total depths of the 54 wells amounted to 121,468 feet, an average of 2,249 feet per well. The completions included 31 in Queensland, 9 in New South Wales, 7 in Western Australia, 3 in Victoria, 2 in Papua, and 1 each in South Australia and Northern Territory.

At the end of 1959, six wells were drilling in Australia, including two each in Queensland, New South Wales, and Western Australia.

Exploration. Exploratory work was generally more extensive in Australia in 1959 than previously, although there was a decrease in seismic work. There were about twice as many party-months of work in 1959 as in 1958 in gravity, magnetic, and geological prospectiing, and three party months of air photo work, against none in 1958 (Table 2). The exploration was well distributed over the whole country.

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Thornycroft Sandmaster 252" wheel base Oilfield Truck. Hands-England full Oilfield Body. 60,000 lb. winch, heavy duty gin poles, winch operated gin pole risers and folding SAE king pin.

Hands-England 75,000 lb. capacity, tandem axle Oilfield Float 30' 0" long and 9' 6" wide, folding support legs and inverted 36" fifth wheel.

Truck and Float on Michelin 18.00 x 25. Sahara "X" sand tires.

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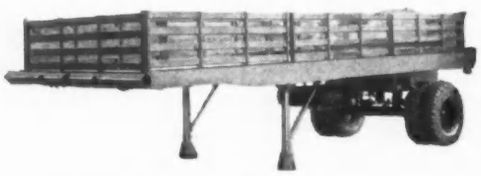

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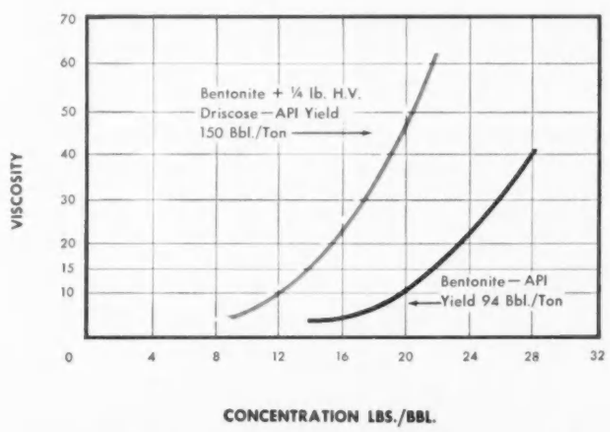
DRILLING DATA REPORT 60-3

High Viscosity DRISCOSE* Increases Bentonite Yields and Controls Viscosity Of Low Solids Muds

As drilling costs continue to rise, contractors and operators are looking for more and better ways to economize. For years our engineers have been showing them how low solids muds made with Driscose help keep drilling costs to a minimum. We're accustomed to getting good reports from all over the globe about the many money-saving benefits that Driscose makes possible—such as increased penetration rates, extended bit life, low water loss and many more. Just recently, though, we've heard a surprising number of comments about how well Driscose performs in souping up bentonite yields and controlling viscosity. These are old tricks for Driscose and are often taken for granted by mud engineers.

How Much Driscose to Control Viscosity?

Our High Viscosity Driscose, as the name implies, is highly effective as a viscosifier. The graph below shows a big increase in viscosity with only ¼ pound per barrel of High Viscosity Driscose. A ratio of one 50-pound sack of Driscose to 8 or 10 sacks of bentonite is a common cure for viscosity problems in the field. Naturally, the requirements of any given well must be considered, but, in general, a low solids mud system can be controlled with less than ½ pound per barrel of this 99+% pure product.



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Long before low solids muds became so popular, our medium grade Driscose had already proved itself as a fast, economical treatment to increase bentonite yields. Our High Viscosity Driscose is even more efficient. The chart shows the effect of less than ¼ pound per barrel of High Viscosity Driscose on the API yield—a 60% increase from 94 to 150 barrels yield per ton. Our research people have shown us that a ratio of one pound of High Viscosity Driscose to 1¾ pounds of bentonite will produce a mixture with an API yield of approximately 2200 barrels per ton.

Reduced Drilling Costs

Our field data proves that operators using low solids, high-viscosity Driscose muds can expect big savings in mud-up costs because the need for bentonite and other additives is so greatly reduced. But in addition to lower initial mud costs, the effects of controlled viscosity can and do produce sizable savings through faster penetration, longer bit life, fewer fishing jobs and reduced downtime. When you figure the cost of downtime from $30 to $300 and up, a little Driscose to control the mud system is an economical buy.

For more details on money-saving, low solids muds made with Driscose, see your nearest mud service dealer . . . or write us direct for technical literature.

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AUSTRALIA

help provide its petroleum requirements. Consumption in 1959 averaged 205,867 barrels per day (Table 3). To meet the needs, there were imports of 32,620 bpd of products and 202,533 bpd of crude oil. The seven Australian refineries have combined capacity of 235,000 bpd, and in 1959 ran to stills 203,856 bpd. An additional refinery is planned.

Leases. Leases have been granted by the Commonwealth government to more than a score of oil companies representing American, Australian, and British interests. Information on the lease holdings was presented by WORLD OIL, March 1960, Pages 87, 88, and 89, in tabulations and maps.

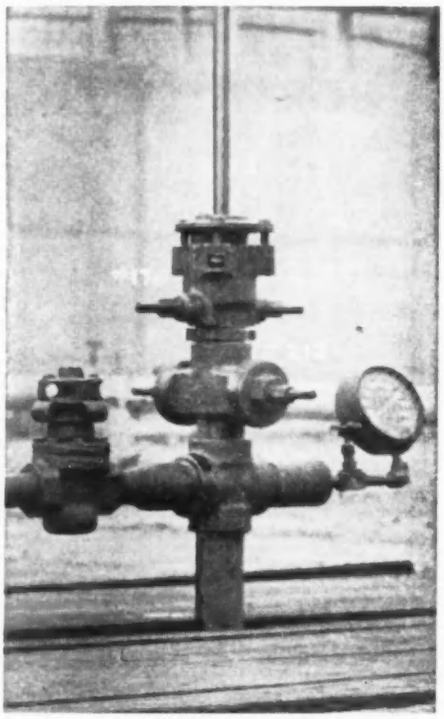
TABLE 3—Petroleum Consumption and Refining in Australia in 1959

ITEM	Bbls. Daily
Consumption	205,867
Imports of products	32,620
Imports of crude oil	202,533
Refining capacity, Dec. 31	235,000
Average runs	203,856

Number of refineries: 7 in operation; 1 more planned.

TABLE 4—Wells Drilled in Australia in 1959, by States and Companies (Completed or abandoned during year, or suspended or drilling at end of year.)

State, Company, Well, and Location	Status	Depth, Feet
Queensland—		
Humber Barrier Reef Oils Pty. Ltd., Wreck Island 1	Abnd	1,898
Associated Freney Oil Fields N. L., Cooroorah 1	Drlg	2,822
Delhi Australian Pet. Ltd., Betoota 1	Drlg	1,701
Condamine Oil Ltd., Speculation 1	Susp	0
Longreach Oil Ltd., Balmoral 6	Abnd	1,268
Australian Oil & Gas Corp. Ltd., Mirri Mirri 2, complete as water well	Comp	4,645
Santos-Delhi Australian Pet. Ltd., Oaky Hole 1	Abnd	1,000
Nicholson River 2	Abnd	300
Nicholson River 2A	Abnd	50
Mornington Island 3	Abnd	1,000
Mornington Island 4	Abnd	1,000
Mornington Island 5	Abnd	1,000
Mornington Island 6	Abnd	1,000
Mornington Island 7	Abnd	1,000
Mornington Island 8	Abnd	1,000
Mornington Island 9	Abnd	600
Mornington Island 10	Abnd	600
Mornington Island 11	Abnd	1,000
Mornington Island 12	Abnd	1,000
Mornington Island 13	Abnd	1,000
Mornington Island 14	Abnd	1,000
Mornington Island 15	Abnd	1,000
Mornington Island 16	Abnd	1,000
Mornington Island 17	Abnd	1,000
Mornington Island 18	Abnd	1,000
Mornington Island 19A	Abnd	280
Mornington Island 19	Abnd	650
L. H. Smart Oil Expltn. Ltd., Cannaway Downs 2	Abnd	1,575
Gumbla 3	Abnd	1,835
Standard Gas Pty. Ltd., Gumdate 6	Abnd	288
Cribb Island 7	Abnd	235
Cribb Island 8	Abnd	362
Cribb Island 9	Abnd	249
Cribb Island 10	Abnd	245
South Australia—		
Delhi Australian Pet. Ltd., Innamincka 1, plugged back and completed as water well	Comp	12,637
Victoria—		
Lakes Oil Ltd., East End 1	Abnd	1,230
A.E. Ekberg, No. 1 (Dome No. 5), standing	Stnd	1,200
Frome Broken Hill Co. Pty. Ltd., Port Campbell 1, testing, drilling completed	Comp	5,965
New South Wales—		
Australian Oil & Gas Corp. Ltd., Camden 6	Comp	1,981
Camden 7	Comp	1,702
Camden 8	Comp	2,102
Camden 9	Comp	2,104
Camden 10	Comp	1,743
Nulgoa 2	Abnd	5,630
Clarence River Oil Expln. Co., Grafton 3	Drlg	1,290
E. J. Ellis, Junee 1, standing	Stnd	1,149
Sun Oil Co. of California, Sun 1	Abnd	2,009
J. C. Reynolds, Dunedoo 1	Abnd	257
Australian Iron & Steel Ltd., Cordell Park 1	Drlg	1,327
Western Australia—		
West Australian Pet. Pty. Ltd., Frome Rocks 1	Abnd	4,000
Frome Rocks 2	Abnd	7,504
Meda 2	Abnd	7,628
Thangoo 1	Abnd	3,475
Thangoo 1A	Drlg	2,800
Exoil Pty. Ltd., Eyre 1	Drlg	1,400
Bureau of Mineral Resources, No. 8 (Mt. Madeline)	Abnd	3,004
No. 9 (Daurie Crk.)	Abnd	2,299
No. 10 (Beagle Ridge)	Susp	3,910
Northern Territory—		
Westralian Oil Ltd., Spirit Hill 1	Susp	2,458
Papua-New Guinea—		
Australasian Pet. Co. Pty. Ltd., Puri 1, total depth 10,000 ft; yielded oil, then water; plugged back; deviated hole Puri 1A, 6,090–7,528 ft, abandoned; deviated hole Puri 1B, 3,871–8,520 ft, also abandoned	Abnd	10,100
Bwata 1	Abnd	7,302



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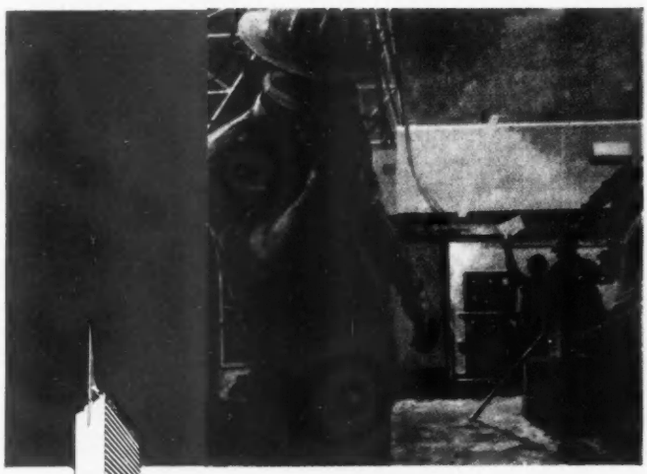

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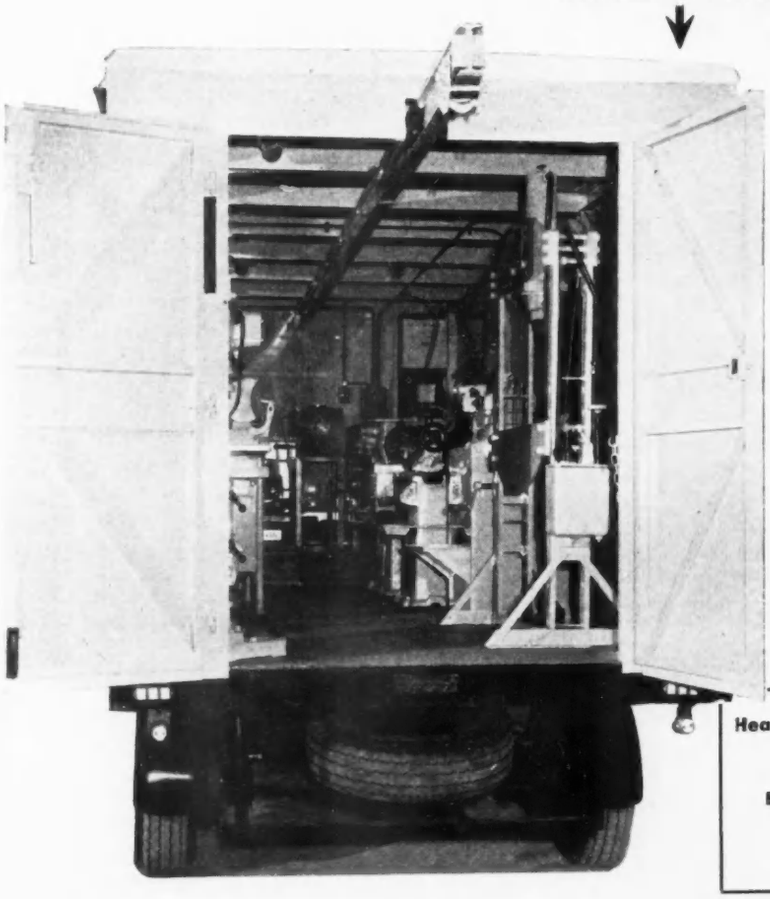

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New Zealand . . . exploration continuing

SHELL, B. P. AND TODD OIL SERVICES, LTD., is continuing exploration in the Taranaki district of New Zealand. Kapuni 1, located 11 miles from Hawera, in the west coast area of the North Island, was drilled in 1959 to a record New Zealand depth of 13,040 feet.

The results obtained from that well were sufficiently encouraging to justify an extension of the exploration activities. At mid-year of 1960, arrangements were being finalized for the drilling of a further well near Tarata in Taranaki. A drilling rig with a greater capacity than that situated at Kapuni was being assembled for the new well. It was expected that drilling would commence before the end of this year.

B. P., Shell, and Todd Petroleum Development, Ltd., has continued with geological and geophysical work in the Gisborne and Hawkes Bay districts in the east coast area of the North Island. A well named Mangaone No. 1 at mid-year 1960 was about to be drilled on a location a few miles from Nuhaka in Hawkes Bay. This well is to be drilled with the rig used at Kapuni. It was expected that a depth of approximately 12,000 feet would be reached.

Meanwhile, there was very little exploration activity in other parts of New Zealand.

Production. Edgmont Oil Wells, Ltd., of New Plymouth, still holds the only current petroleum license in New Zealand and is the only producer of crude oil. During 1959, the company produced 4,500 barrels of crude oil, an average of 12.3 barrels daily, compared with 4,571 barrels in 1958. The production came from four wells.

In addition, 5,457,300 cubic feet of natural gas was produced. It was supplied to the New Plymouth gas works.

Licenses. In effect in New Zealand currently are 159 petroleum production and mining licenses, covering 24,128 square miles, as listed in a table herewith.

Managone 1 near Nuhaka in the North Island of New Zealand is the first deep test well for the British Petroleum-Shell and Todd Petroleum Development Co. If necessary, drilling is to be continued to a depth of 12,000 feet. The British Petroleum group is the managing partner and is responsible for administration and staff.

Petroleum Production and Mining Licenses Held in New Zealand at Mid-Year 1960.

District	Number of Licenses	Area In Square Miles
Auckland	10	656
Taranaki-Wellington	33	5,722
Gisborne-Hawkes Bay-Wairarapa	77	13,198
Malborouth	6	655
Nelson	3	69
West Land	5	488
Canterbury	17	2,786
Otago	4	227
Southland	4	327
Total	159	24,128